

A
GENUINE AND UNIVERSAL
SYSTEM
OF
NATURAL HISTORY;

COMPRISING THE
THREE KINGDOMS OF
ANIMALS, VEGETABLES, AND MINERALS,

ARRANGED UNDER THEIR RESPECTIVE
CLASSES, ORDERS, GENERA, AND SPECIES,

By the late Sir CHARLES LINNÆUS,

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PROFESSOR OF NATURAL HISTORY IN THE ROYAL SOCIETY
OF GOTTINGEN.

Faithfully translated, and rendered more complete by the Addition
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of MARK ELIEZER BLOCH; the Amphibious Animals, Rep-
tiles, Insects, &c. in the costly Works of ALBERTUS SEBA,
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AN UNIVERSAL
S Y S T E M
OF
NATURAL HISTORY.

OF VEGETABLES.

VEGETABLES have life without voluntary motion. They consist principally of a root, inserted into the earth and absorbing moisture; a trunk rising above the earth, generally spreading out into branches bearing leaves, and supporting the fructification, i. e. the flowers, fruit, and seed.

Vegetables, that is to say, trees, plants, and herbs, are distributed into Classes; the classes are divided into Orders; and, as in the other departments of natural history, the orders are subdivided into Genera, containing all those which agree in their parts of fructification; and the genera are again branched into Species, consisting of every individual whose form and structure is invariable and perpetual. These particulars form what is called the Science of BOTANY, from the Greek word *βοτάνη*, an herb.

This branch of knowledge is very ancient. Solomon is recorded as having known all the plants, from the cedar of Lebanon to the hyssop upon the wall. Hippocrates is the next, of whom we have any valuable account: he speaks of the virtues of about two hundred and thirty plants, but does not describe them.

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Cratevas, or Crateias, a cotemporary of Hippocrates, describes those plants of whose virtues Hippocrates gives an account. After him flourished Aristotle, and then Theophrastus, the disciple of Aristotle, about 300 years before Christ. There yet remain nine books of his on the history of plants, and six on the causes of them: he reckons about 500 plants.

Among the Romans, Cato, Varro, Virgil, and Columella, might be mentioned; but the most eminent were Dioscorides, who lived under Antony and Cleopatra; and C. Plinius Secundus, under Vespasian and Titus. The former is called the *prince of botanists*, though the number of plants he has described amount only to 600; but then he surpassed all others in ascertaining their virtues and medical use. Galen, though he did not write professedly on botany, has introduced many useful observations on the subject; and other physicians prosecuted this study, as far as it was immediately connected with their profession, from the second to the sixth century of the Christian æra; such as Oribasius, Aetius, Trallianus, and P. Ægineta.

The principal Arabian botanists, who cultivated this science from the eighth to the twelfth century, were Mesue, Serapio, Razis, Avicenna, and Averhoes. The succeeding period, till the fifteenth century, was very unfavourable to science: however, in this century, and especially in the next, botany was revived by the pens of Leonicensus, Brasavolus, Cordus, Fuchsius, Bodæus, Matthiolus, Delacampius, and others. Turner, Gerard, and Tradescant, were the first botanists in England: they applied themselves to the culture of medical and rare plants, towards the close of the sixteenth century. But it was after this period that botany began to acquire a considerable degree of importance and reputation, by the ingenuity and industry employed in collecting and classing new species of plants. It would be tedious

to recount all the names of those who are distinguished in this respect; let it suffice to mention Gesner, Dodonæus, Cæsalpinus, Prosper Alpinus, the two Bauhines, Columna, Parkinson, Plukenet, Morrifon, Malpighii, Grew, Hermannus, Ray, Magnol, Tournefort, Sloane, Sherrard, Linnæus, and P. Miller; and, in our present day, those who have so ably and elegantly improved the works of the preceding authors; as Dr. Gmelin, the younger Linnæus, Hoffman, Jacquin, Retzius, Schreber, Bulliard, Berkenhout, Hedwig, Thunberg, Jn. Miller, Hill, Dickson, Stackhouse, Vellely, Milne, Blackwell, Trew, Curtis, Smith, Woodville, Withering, &c. Among which notices we must not omit the very elegant collection of rare and curious plants from the coast of Coromandel, recently published by Dr. Roxburgh, under the inspection of Sir Joseph Banks, at the instance of the East-India Company.

But of all the means which have been thought conducive to the successful cultivation of botany, none have proved of so much importance as the clear and distinct methods of arrangement, whereby the several classes, genera, species, and varieties, of plants, may be readily distinguished. Indeed it is easy to foresee, that, in proportion as the system of Linnæus prevails, and different writers agree in adopting the same language, the study of botany must be greatly facilitated and promoted. That celebrated writer distributes the systems which had previously obtained into *heterodox* and *orthodox*. The former are founded in an alphabetical arrangement; in the structure of the root; in the different species of flowers: in the habit of plants; their time of flowering; their native soil and climate; their medicinal use, and the order of the dispensaries. The *orthodox* systems, as he calls them, are either universal or partial; such as belong to plants in general, or such as are accommodated to the nomenclature and arrangement of particular kinds.

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The universal systems are four; though, by various modifications, this number has been considerably augmented. Linnæus has distinguished the several patrons of them under the classes and appellations of *Fructistæ*, *Corolistæ*, *Calycistæ*, and *Sexualistæ*. The *Fructistæ* are such as form the several classes of vegetables from the pericarpium, the seed, and the receptacle; of this number are Cæsalpinus, Morrison, Ray, Knaut, Hermann, and Boerhaave. The *Corolistæ* distinguish the several classes by means of the corolla and petals; such are Rivinus and Tournefort, and their disciples. The *Calycistæ* distribute them from the calyx, as Magnol; and the *Sexualistæ* found their system on the different sexes of plants.

To this compendious abstract, it may be proper to add, that Cæsalpine, an Italian physician in 1583, was the first systematic writer; and he distributed plants into classes according to the form of their seeds. Ray, from being first a *fructist*, became afterwards a *corolist*. Boerhaave endeavoured to combine the systems of Hermann, Ray, and Tournefort; but as the system of the latter was at one time very generally received, and, notwithstanding the prevalence of the Linnæan or sexual system, has still some advocates, it may be proper to observe, that Tournefort considers plants as composed of five parts, viz. roots, stalks, leaves, flowers, and fruit: neglecting the three former parts, he distributes them into various classes according to the disposition and structure of the flower; and, in resolving them into genera, he takes into consideration both the flower and fruit. Mr. Ray, urged chiefly by the short duration of the flower, sought the characters of the several genera, not merely in the flower and fruit, but in the figure of the organical parts, as the leaves, stalks, and roots, and in their colour, smell, taste, and the outward surface of the whole plant.

The sexual system of botany is founded on a discovery

covery that there is in vegetables, as well as in animals, a distinction of sexes. This was not wholly unknown to the ancients; but their knowledge of it was very imperfect. It will be seen hereafter, that the flowers of the generality of vegetables are hermaphrodite, containing in themselves the characters of both sexes; but that, in the classes monoecia and dioecia, the sexes are parted, and allotted to different flowers; and that, in the class dioecia in particular, the sexes are even on different plants, the male flowers growing all upon one plant, and the female upon another. Now this last circumstance the ancients had observed: indeed it could hardly escape their notice; for the palm-tree, whose fruit was in esteem, being of the class dioecia, a very little observation was requisite to teach them, that in these trees the corolla of the male was necessary to ripen the fruit of the female. It seems therefore extraordinary, that this discovery should not have led the ancients to detect the whole process of nature in the propagation of the various species of vegetables; and yet it does not appear, by any of their writings that are come down to us, that they went farther than this obvious remark upon the palm-tree, and some similar notices concerning the fig. They had, indeed, from what they saw in these plants, formed a notion that all others were male and female likewise; but this notion was false, the far greater part having hermaphrodite flowers, and serves to convince us, that what they discovered of the palm and fig was only a right guess, and not founded on any knowledge of the anatomy of flowers, either in those trees or any other.

In this dark state the doctrine of the sexes of vegetables remained, not only through all the ages of antiquity, but almost to the end of the seventeenth century, the moderns seeing no more of this doctrine than the ancients had done before them; and hence we have to this very hour in use, the false distinctions
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of *male* and *female* species of cornus, pæony, cistus, and many others, which have all hermaphrodite flowers, the distinction in these cases being grounded on nothing more than some difference in the habit of the two species with which the sexes are no ways concerned.

The honour of having first suggested the true sexual distinctions in plants appears to be due to our own countryman, Sir Thomas Millington; from whose hints Dr. Grew, as the doctor himself acknowledges, was led to the observations he has given on this subject, in his Anatomy of Plants. After this, Camerarius, Moreland, Geoffrey, Vaillant, Blair, Jussieu, and Bradley, pursued their enquiries and experiments so far as to remove all doubt concerning these discoveries; and, lastly, the great Linnæus founded thereon the system of botany, of which it is the object of these pages principally to treat and explain.

The sexual hypothesis, on its first appearance, was received with all that caution that becomes an enlightened age; and nature was traced experimentally through all her variations, before it was universally assented to. Tournefort refused to give it any place in his system; and Pontedera, though he had examined it, treated it as chimerical; but the proofs which Sir Charles Linnæus has stated amongst the aphorisms of his Fundamenta Botanica, and farther explained and illustrated in his Philosophia Botanica, are so clear, that the birth of animals is not more evidently the consequence of an intercourse between the sexes, than that of vegetables; and it would be now as ridiculous for any one, who has investigated the subject, to doubt of the one as of the other. We shall not attempt to lay all these proofs before the reader; but as it may be satisfactory to see some fact established, that carries conviction with it, we shall here introduce an extract from Mr. Mylius's letter from Berlin, which is inserted in the Philosophical Transactions,

Transactions, vol. xlvii. concerning a remarkable experiment made on the palm tree.

“ The sex of plants (says Mr. Mylius) is very well confirmed, by an experiment that has been made here on the *Palma major foliis flabelliformis*. There is a great tree of this kind in the garden of the Royal Academy. It has flowered and borne fruit these thirty years, but the fruit never ripened, and when planted it did not vegetate. The palm-tree, as you know, is a *planta dioecia*, that is, one of those in which the male and female parts of generation are upon different plants. We having therefore no male plants, the flowers of our female were never impregnated with the farina of the male. There is a male plant of this kind in a garden at Leipzig, twenty German miles from Berlin. We procured from thence, in April 1749, a branch of male flowers, and suspended it over our female ones; and the experiment succeeded so well, that our palm-tree produced more than a hundred perfectly-ripe fruit, from which we have already eleven young palm-trees. This experiment was repeated last year, and our palm-tree bore above two thousand ripe fruit.”

A similar fact may also be adduced from the cultivation of the palm or date-tree in Africa, where dates supply the place of corn, and afford sustenance to the people. The plantations are made in constant succession, and consist chiefly of female plants: they flower in April and May, at which season the Arabs cut the male branches to impregnate the female: for this purpose they make an incision in the trunk of each branch they wish should produce fruit, and place in it a bunch of male flowers; without this precaution the palm-tree would produce only abortive fruit. In some districts the male branches are only shaken over the female. This practice of impregnating the date-tree is very ancient: Pliny describes it with great accuracy; and Kempfer informs us how necessary it

was found by the oriental people, who live upon the produce of the palm-tree, to plant some male trees among the females, if they hoped for any fruit. And he says it was the practice of these people, during the rage of war, to cut down all the male palms, that a famine might afflict their proprietors; and sometimes even the inhabitants themselves would destroy the male trees when they dreaded an invasion, that their enemies might find no sustenance in the country.

Thus the sexual hypothesis was evidently known to the ancients, though the discrimination of the parts supposed to be the organs of generation in vegetables, is to be ranked among the discoveries and improvements of modern times.

OF THE STRUCTURE OF VEGETABLES.

OF the theory of Vegetation, or of the growth, propagation, and nutriment, of vegetables, our knowledge is still slight and superficial. A close inspection into the structure of plants affords the best ground for reasoning on this subject; and, indeed, every thing beyond it is little better than mere fancy and conjecture. On making a transverse section of a tree, it appears to consist of three distinct parts, the bark, the wood, and the medulla, or pith. The bark consists of two parts, the cuticle and the true bark. The cuticle of plants affords an external covering to all their parts. It consists of numerous layers, easily separable from each other, and of which the fibres are circular. The true bark may be considered as a congeries of cellular substance, in which are placed two kinds of organs, the vessels peculiar to the plants, and the longitudinal fibres. Of the use of these nothing can be said at present.

On removing the bark, the wood appears. Its substance is denser than the bark, and its structure more difficult to be demonstrated. But it has been discovered likewise to contain *vasa propria*, and longitudinal

itudinal fibres, and, besides these, large vessels with spiral coats, which run from one end of the tree to the other, and are denominated *vasa aëria*, or air-vessels.

Between the wood and the pith lies a green-coloured substance, first accurately described by Dr. John Hill, and by him affirmed to contain all the parts of the plant in embryo: he gave it the name of *corona*. In the centre of the tree resides the pith, which, in young plants, is very abundant. As they approach to maturity it grows drier, and appears in a smaller quantity; and, in very aged trees, it is entirely obliterated. Its substance is cellular, and, according to the author just mentioned, it is of a similar structure in all plants.

These are the solid parts of vegetables. But there are likewise fluids or juices in vegetables; and these are of two kinds. The one is of the same nature in all the variety of vegetables: the other varies according to the different plants in which it exists. The former, which is called the *succus communis*, when collected early in the spring, from an incision made in the birch or vine, differs little from common water. The latter, which is named the *succus proprius*, possesses various properties in various plants, and gives to each its sensible qualities. These two juices never mingle with each other in the tree, and the latter is found in the *vasa propria* only.

It is not yet ascertained, whether the juices of plants are transmitted through vessels, or a cellular substance. Each side of the question has had its advocates, who have supported their respective opinions with probable arguments; but it is to be regretted, that, on so interesting a subject, no conclusion can be formed from the actual dissection of vegetables. It, however, seems most probable, that all the fluids of plants are transmitted through vessels.

Botanists have made many experiments to ascertain

the course of the sap. Early in the spring, when the sap begins to flow, incisions have been made in the trunk and branches of the trees, as far as the pith; and, in such cases, it has been constantly found, that a larger quantity of sap flowed from the superior, than from the inferior, margin of the incision. This circumstance led to the opinion, that in the beginning of the spring great quantities of moisture are absorbed by trees from the atmosphere, and hence the source of the abundance of sap. But this conclusion is found to disagree with the phenomena of nature, from the two following experiments: 1. Incisions of various heights being made in the stem of several plants, their roots were immersed in a decoction of log-wood. The roots absorbed the coloured liquor, which at length began to flow from the superior, and not from the inferior, margins of the incisions; nor had the liquor extended itself much upwards, beyond the margin of the incision from which it was discharged. 2. In the season, when the sap flows most abundantly, called the *bleeding season*, a deep cut was made into the branch of a growing vine, and the greatest quantity of sap was discharged from the upper margin of the incision: but a branch of the same tree, cut in the same manner, being inverted, the sap flowed most copiously from the other margin of the incision, which of course was now that next the root.

On the other hand, the following experiments may be brought to prove, that, in the bleeding season, the sap ascends from the roots towards the branches. 1. Early in the spring, when little or no sap had as yet entered the plant, Dr. Hope made a number of incisions, of different altitudes, into the root and stem of a birch. As the sap rose, it first flowed from the superior margin of the lowest incision, and then, in regular succession, from the upper margins of the other incisions, till, at last, it reached the highest. 2. If, in the beginning of the bleeding season, before the

the sap is found in the stem or branches, an incision be made in the root of a vine, a considerable flow of sap will follow the wound. 3. The quantity of sap is very generally proportioned to the humidity of the soil.

When a portion of the bark and wood of the pine is cut from the stem, the *succus proprius* flows in considerable quantity, both from the upper and under margin of the incision. Hence it occurred to botanists, that this juice might have little or no motion, and that its efflux from such an orifice might depend entirely on its being freed from the pressure of the bark and wood. But we cannot accede to this opinion: for although in the beginning, the *succus proprius* flows from both margins of the incision, in a little while it is discharged from the superior margin only. Hence it appears clearly, that the course of this juice in its vessels is never from the roots towards the branches, but always in the contrary direction. But besides the vessels of the *succus proprius*, and those conveying the sap, we must take into our view the air-vessels, or *vasa aëria*. These are chiefly situated in the wood, leaves, and petals; but are wanting in the bark of trees, and in the herbaceous plants. They are formed by a number of small filaments, spirally rolled up, so as to form a cavity in the middle.

The name of *vasa aëria* has been given them, because they are empty of liquor, and because a great quantity of air is certainly found in the wood of plants, where these vessels are chiefly placed, and where there is no peculiar organization. They are supposed to be the instruments of respiration in vegetables; but in what manner this function is performed, is not yet clearly understood.

Dr. Hill has demonstrated, that the cuticle of plants is an organized substance, containing vessels. In trees and shrubs these vessels have an external opening: but in the herbaceous plants this is wanting. Trees
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and shrubs only are possessed of *vasa aëria*; and, when a plant is placed under the exhausted receiver of an air-pump, the air enters through the cuticles, and only issues from the wood, in which the *vasa aëria* are situated. From these circumstances taken together, and considered attentively, we have reason to conclude, that the air's proper entrance to the *vasa aëria* is through these cuticular vessels. Thus, in the early part of the spring, the gentle heat expands the mouths of these vessels, before contracted by the winter's cold. Into these orifices the external air rushes and presses down to the roots. To these it gives energy, as it does to the moving fibres of animals; and, by its pressure, it may assist in propelling the juices upwards. An additional quantity of air is evolved by the internal motions of the plant, and the whole passes off with the perspirable matter. In this way, there seems to be a circulation of air through plants, assisting and assisted by the powers which move the juices. On this account, trees overgrown with moss have few leaves, weak shoots, and no fruit. The practice of gardeners is, therefore, to be commended, who, in the spring, strip the moss from the bark of aged trees, and, thus facilitating the accession of the air, restore them to verdure and fruitfulness.

We are next to consider capillary attraction, which has generally been accounted the cause of the motion of the juices of plants; and the permanence of the action of this power has been supposed to depend on the evaporation from the leaves. Of late years, indeed, botanists have ascribed to plants a vital power, which they believe assists the flow of the juices; and this opinion is supported by the following reasons.

1. The descent of the juices, that is, their return from the branches to the roots, cannot be explained without the supposition of a vital power regulating the motion. A flow of fluids, through capillary tubes, will only take place when the resistance at the one end is diminished.

diminished. This might account for the rising of the sap, when warmth is applied to the leaves, but cannot account for its descending in the same circumstances, that is, when the atmosphere is warmer than the earth. But this takes place constantly with respect to the succus proprius, and it is probable that part of the sap has the same course both in the day and night.

2. The exertions of many plants, on the application of stimuli, afford another argument in support of their muscular power; and the spontaneous motions of other plants confirm the same opinion. 3. Light, admitted to plants, increases their perspiration, and causes a leaf, before inverted, to resume its natural position. The influence of darkness counteracts these effects, and it produces what is called *sleep* in plants, although the heat of the atmosphere be not diminished. These facts seem to prove the irritability, or muscular power, of vegetables. 4. If the fluids of plants are conveyed through vessels, can we suppose these tubes to be of so small a diameter, as, by capillary attraction alone, to raise the juices from the roots to the summits of the loftiest trees? 5. On the supposition of the fluids being moved entirely by capillary attraction, how happens it, that the sap of the vine flows from an incision made in the spring, and not from one made in the summer? In this case, as the vessels remain the same, and the heat is at least not diminished, the efflux of sap ought to be equally copious in summer as in spring. 6. Capillary tubes, filled with liquor, do not discharge their contents when broken across. But from the stem of a vine, cut transversely, a large quantity of fluid is discharged, as has been demonstrated by Dr. Hales.

Plants, as well as animals, perspire; and, in both cases, this function is essential to health. By the experiments of Dr. Hale and M. Guettard, it appears, that the perspirable matter of vegetables differs in no respect from pure water, excepting that it becomes sooner putrid. The quantity perspired varies, according

According to the extent of the surface from which it is emitted, the temperature of the air, the time of the day, and the humidity of the atmosphere. As the leaves form the greatest part of the surface, it is natural to suppose, that the quantity of these will very materially affect the quantity of the perspiration. Accordingly, the experiments of Dr. Hales have ascertained, that the perspiration of vegetables is increased or diminished, chiefly, in proportion to the increase or diminution of their foliage. The degree of heat in which the plant was kept, according to the same author, varied the quantity of matter perspired; this being greater, in proportion to the greater heat of the surrounding atmosphere. The degree of light has likewise considerable influence in this respect; for Mr. Philip Miller's experiments prove, that plants uniformly perspire most in the forenoon, though the temperature of the air, in which they are placed, should be unvaried. M. Guettard likewise informs us, that a plant, exposed to the rays of the sun, has its perspiration increased to a much greater degree than if it had been exposed to the same heat under the shade. Finally, the perspiration of vegetables is increased in proportion as the atmosphere is dry, or, in other words, diminished in proportion as the atmosphere is humid. The more vigorous and healthy the plant, the more copious the perspiration; this function, like the rest, depending much on the vital energy. Excessive perspiration seems to hurt, and even sometimes to destroy, vegetables; defective perspiration is equally injurious. It is also found, that this function is performed, chiefly, if not altogether, by the leaves and young shoots. That it may be properly carried on, all leaves are deciduous; in those trees called *ever-green*, there being a constant succession of leaves, to prevent the organ of perspiration from becoming rigid.

Dr. Hales first observed, that a quantity of moisture
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is absorbed by plants, when exposed to a humid atmosphere. This absorption, as well as the perspiration, is performed by the leaves; but in what manner is not yet ascertained. Experiments made by M. Guettard show, that perspiration is more considerable from the upper, than from the under, surface of the leaves; and those of the same author, of Duhamel, and Bonnet, demonstrate, that absorption, on the contrary, is much greater at the inferior surface than at the superior. To prove this, the superior surface of one leaf, and the inferior surface of another, were covered with varnish, and the consequence was, that the former, in a given time, suffered little diminution of weight, but the latter became much lighter. Again, similar leaves were laid upon a surface of water, and it followed, that those which had their superior surface inverted, gained little weight, and for the most part died in a few days; while such as had their inferior surface applied to the water, became much heavier, and flourished many months. These facts make it evident, that perspiration and absorption are not performed by the same vessels, but that each has its peculiar organs.

It has been commonly supposed, that perspiration takes place, chiefly, when the air is warm; and absorption, on the other hand, when it is cold and moist. But, unless the vessels peculiar to absorption, which are placed in the under surface of the leaves, were kept constantly in action, they would necessarily collapse or decay. All absorbing organs have a peculiar structure, and an action depending on life: that such an organization is present in the leaves of plants, it is reasonable to conclude, because dried leaves do not absorb. The same reasoning is applicable to the absorption performed by the roots: for when a small portion of the root of a hyacinth, growing in water, is cut off, the whole root dies, and new roots are shot

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out, having their extremities peculiarly adapted to the absorption of nourishment.

The noxious matter, carried off by perspiration, requires large dilution to prevent its hurting the delicate structure of the leaves, and in this state accordingly it is thrown out on their surface. Here the noxious part is excreted, but part of the diluting fluid is re-absorbed, to serve the purpose of secretion, which could not be performed, unless the common juice or sap were previously prepared. In the same manner, in the animal body, the saline and putrid matter, carried off by the urine, must be liberally diluted, to prevent it from injuring the tender structure of the kidneys; yet, when it is safely lodged in the bladder, a part is re-absorbed, and the grosser excrementitious matter is alone thrown out. Something of the same kind happens in the perspiration of animals. They certainly take in something useful from the surface of their bodies; and this is probably performed by vessels opening outwards, different from the common exhalants. The great quantity of water absorbed during the use of the pediluvium, and that singular symptom in diabetes, of the patient's voiding a much greater quantity of urine than there is liquor taken in by the mouth, seem to confirm this assertion.

Plants are possessed of a power of forming their different parts, and this is done by secretion. We may conjecture what the agents are which produce this effect, but in respect to the manner of the operation we are entirely in the dark. In animals, where the vital power is strong, this is the principal agent in producing the new arrangement of parts, which is made in every secretion; but in plants, where this power is weaker, it would be unequal to perform the function, if it were not assisted by absorption and fermentation. Wherever any firm matter is to be secreted, the vessels have a convoluted course, to al-
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low the juice to be fermented, and the thinner parts to be absorbed. In this manner, the stones and kernels of fruits are supplied with nourishment by fibres, which are much convoluted. The proper juice seems to be formed only when the sap has ascended towards the leaves, and is descending to the roots. The pabula, from which vegetables receive the matter of secretion, are contained in the surrounding elements.

Some botanists have conceived, that plants, as well as animals, have a regular circulation of their fluids. Others think this very improbable. On both sides, recourse has been had to experiments; and, from these, conclusions perfectly opposite have been deduced. When a ligature has been fixed round a tree, in such a manner that no juice could be transmitted through the bark, the tree has been found to thicken above the ligature; but below it, to continue of the same circumference. Hence some have concluded, that the sap ascends through the bark. Those who are of a contrary opinion have found, that, in certain cases, the juice ascends through the bark only: for when a portion of the wood has been cut out, and the bark exactly replaced, the growth of the tree has been found to go on unchanged: hence it is said, that the juice is transmitted equally through all parts of vegetables. The experiments adduced on each side of the question are just, but the reasonings on these, by each party, seem equally inconclusive. The analogy of animal nature appears to favour the opinion, that the juice rises through the wood only, and descends only through the bark; but this analogy is not complete throughout. The arteries are not placed in the internal parts alone, nor the veins in the external, but they accompany each other through every part of their distribution. In vegetables, the sap rises *from* the roots, but the proper juice descends *towards* them: in the descent of the juice, the wood acquires its growth, and absorption is a constant action

of the leaves. These observations render it probable, that there is a circulation of the juices; and, if there be, the vessels which perform it, we may reasonably believe, accompany each other through every part of their course.

OF THE PARTS OF VEGETABLES.

A perfect plant is composed of a root; of a trunk or stem, with its branches; and of leaves, flowers, and fruit. By *fruit*, both in herbs and trees, is meant *perfect seeds*, whether accompanied, or not, with an eatable part. The *fructification*, which implies the flower and the fruit, requires the most minute investigation; for on this the sexual system is principally founded. Therefore, to explain this system, and illustrate the curious fabric of a vegetable, we shall investigate its parts, and trace it upwards from the root to the flower; and then unfold the characters of the Twenty-four Classes, into which Linnæus has divided the whole Vegetable Kingdom.

Of the Root.

The *radix*, or root, imbibes the nutritious juices of the earth, and transmits them to the other parts. In point of duration, they are divided into three classes, viz. annual, or abiding only one year; biennial, abiding two years; and perennial, abiding and regenerating several or many years. Every root, after it has arrived at a certain age, acquires a double skin. The first is coeval with the other parts, and exists in the seed; but afterwards there is a ring sent off from the bark, and forms a second skin: as for example, in the root of dandelion, towards the end of May, the original or outer skin appears shrivelled, and is easily separated from the new one, which is fresher, and adheres more firmly to the bark. Perennial plants are supplied in this manner with a new skin every year; the outer one always falls off in the autumn and winter,

ter, and a new one is formed from the bark in the succeeding spring. The skin has numerous cells or vessels, and is a continuation of the parenchymatous part of the radicle. However, it does not consist solely of parenchyma; for the microscope shows that there are many tubular ligneous vessels interspersed through it.

When the skin of the root is removed, the true cortical substance or bark appears, which is also a continuation of the parenchymatous part of the radicle, but greatly augmented. The bark is of very different sizes. In most trees it is exceedingly thin in proportion to the wood and pith. On the other hand, in carrots, it is almost one-half of the semidiameter of the root; and, in dandelion, it is nearly twice as thick as the woody part. The bark is composed of two substances; the parenchyma, or pulp, which is the principal part, and a few woody fibres. The parenchyma is exceedingly porous, and has a great resemblance to a sponge; for it shrivels considerably when dried, and dilates to its former dimensions when infused in water. These pores or vessels are not pervious, so as to communicate with each other; but consist of distinct cells or bladders, scarcely visible without the assistance of the microscope. In all roots, these cells are constantly filled with a thin watery liquor. They are generally of a spherical figure; though in some roots, as the bugloss and dandelion, they are oblong. In many roots, as the horse-radish, piony, asparagus, potatoe, &c. the parenchyma is of one uniform structure. But in others it is more diversified, and puts on the shape of rays, running from the centre towards the circumference of the bark. These rays sometimes run quite through the bark, as in lovage; and sometimes advance towards the middle of it, as in melilot, and most of the leguminous and umbelliferous plants. These rays generally stand at an equal distance from each other in the same plant;

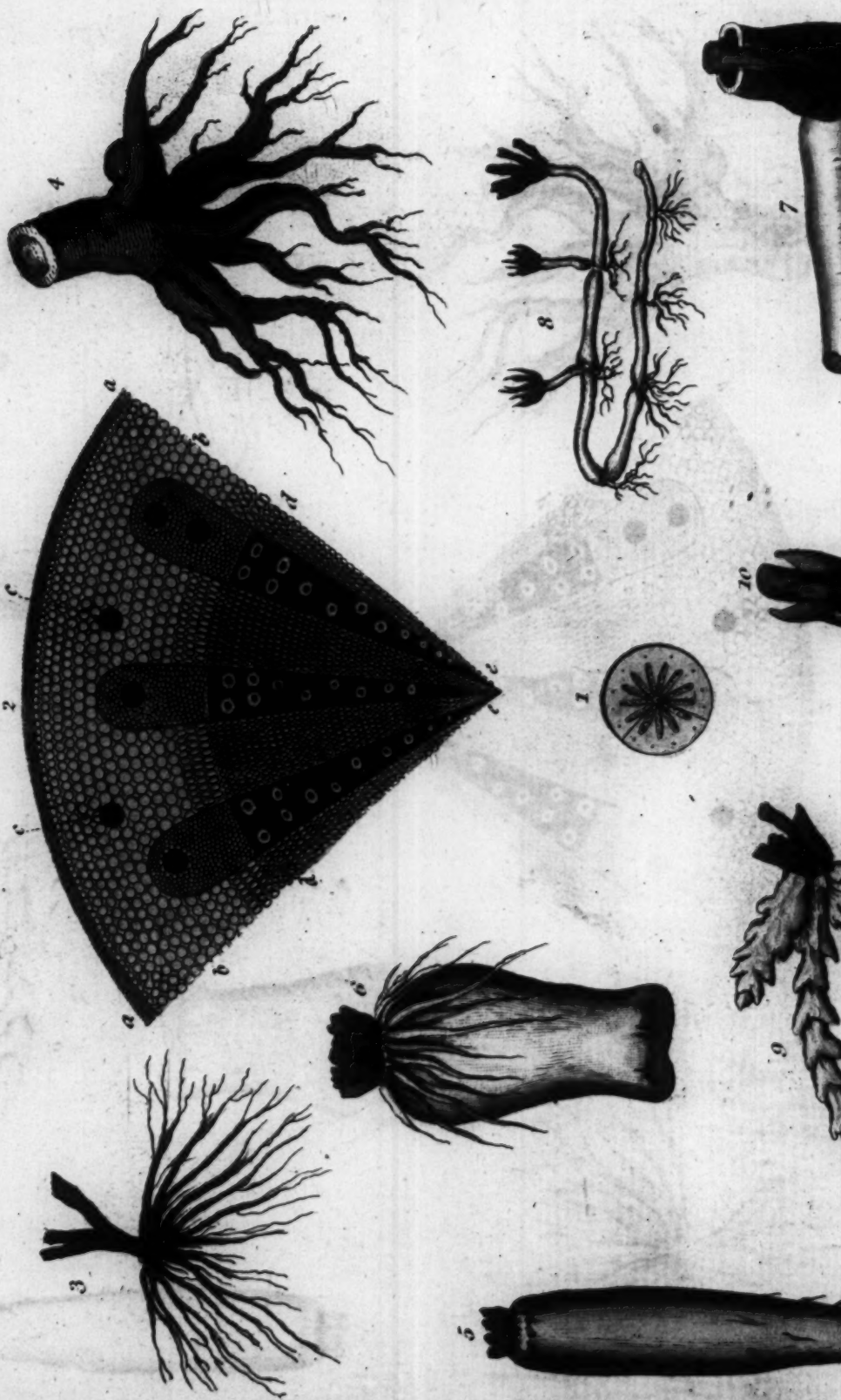
plant; but the distance varies greatly in different plants. Neither are they of equal sizes: in carrot they are exceedingly small, and scarcely discernible; in melilot and chervil, they are thicker. They are likewise more numerous in some plants than in others. Sometimes they are of the same thickness from one edge of the bark to the other: and some grow wider as they approach towards the skin. The vessels, with which these rays are amply furnished, are supposed to be air-vessels, because they are always found to be dry, and not so transparent as the vessels which evidently contain the sap.

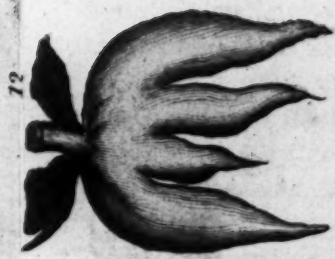
In all roots there are ligneous vessels dispersed in different proportions through the parenchyma of the bark. These ligneous vessels run longitudinally through the bark in the form of small threads, which are tubular, as is evident from the rising of the sap in them when a root is cut transversely. These ligneous sap-vessels do not run in direct lines through the bark, but at small distances incline towards one another, in such a manner that they appear to the naked eye to be inosculated; but the microscope discovers them to be only contiguous, and braced together by the parenchyma. These braces or coarctations are very various both in size and number in different roots; but in all plants they are most numerous towards the inner edge of the bark. Neither are these vessels single tubes; but, like the nerves in animals, are bundles of twenty or thirty small contiguous cylindrical tubes, which uniformly run from the extremity of the root, without sending off any branches, or suffering any change in their size or shape.

In some roots, as parsnep, especially in the ring next the inner extremity of the bark, these vessels contain a kind of lymph, which is sweeter than the sap contained in the bladders of the parenchyma. From this circumstance they have got the name of *lymph-duets*. These lymph-duets sometimes yield a
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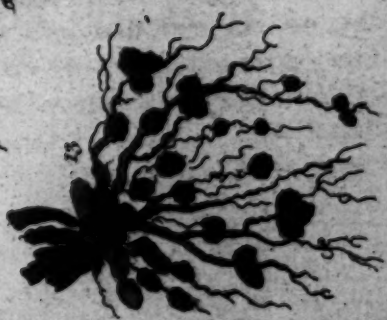
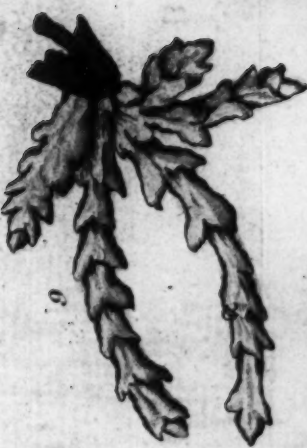
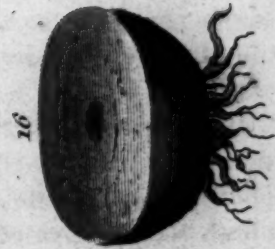
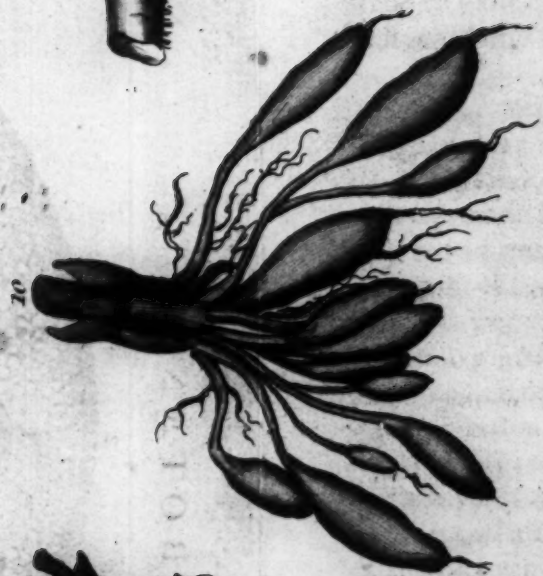
BOTANY.

Plate I.





A. P. de C. sculp.



The different Kinds of Roots.

London, Published on the 24th of October, 1788, by J. Millar.

mucilaginous lymph, as in the comfrey; and sometimes a white milky glutinous lymph, as in the angelica, sonchus, burdock, scorzonera, dandelion, &c. The lymph-ducts are supposed to be the vessels from which the gums and balsams are secreted. The lymph of fennel, when exposed to the air, turns into a clear transparent balsam; and that of the scorzonera, dandelion, &c. condenses into a gum. The situation of these vessels is various. In some plants they stand in a ring or circle at the inner edge of the bark, as in asparagus; in others, they appear in lines or rays, as in borage; in the parsnep, and several other plants, they are most conspicuous towards the outer edge of the bark; and in the dandelion they are disposed in the form of concentric circles.

The wood of roots is that part which appears after the bark is taken off, and is firmer and less porous than the bark or pith. It consists of two distinct substances, viz. The pulpy or parenchymatous, and the ligneous. The wood is connected to the bark by large portions of the bark inserted into it. These insertions are mostly in the form of rays, tending to the centre of the pith, which are easily discernible by the eye in a transverse section of most roots. These insertions, like the bark, consist of many vessels, mostly of a round or oval figure. The ligneous vessels are generally disposed in collateral rows running longitudinally through the root. Some of these contain air, others sap.

The pith is the central part of the root. Some roots have no pith, as the wormwood, tobacco, &c. others have little or none at the extremities of the roots, but have a considerable quantity of it near the top. The pith, like every other part of a plant, is derived from the seed; but in some it is more immediately derived from the bark: for the insertions of the bark, running in betwixt the rays of the wood, meet in the centre, and constitute the pith. It is owing

ing to this circumstance, that, among roots which have no pith in their lower parts, they are amply provided with it towards the top, as in columbine, lovage, &c. The bladders of the pith are of very different sizes, and generally of a circular figure. Their position is more uniform than in the bark. Their sides are not mere films, but a composition of small fibres or threads; which gives the pith, when viewed with a microscope, the appearance of a piece of fine gauze or net-work.

Thus we see, the whole substance of a root is nothing but a congeries of tubes and fibres, adapted by nature for the absorption of nourishment, and of course for the extension and augmentation of the whole plant. To illustrate what has been here stated, we have shown, in the Botanical Plate I. at fig. 1. a transverse section of a root of wormwood, as it appears to the naked eye. Fig. 2. is a section of the same, magnified; *a a*, the skin, with its vessels; *b b*, the bark; the round holes, *c c*, &c. are the lymph-ducts of the bark: all the other holes are little cells and sap-vessels. At *d d* are shown parenchymatous insertions from the bark, with the cells, &c. The rays of the wood are represented at *e e*, in which the holes are the air-vessels.

Roots are divisible into two parts, viz. the *caudex*, or body of the root; and the *radicula*, radicle, or little root. The caudex, or body of the root, both ascends and descends. The ascending caudex raises itself gradually above ground, serving often as a trunk, and produces the herb or plant; and it is from hence Linnæus infers, that all trees and shrubs are to be considered as roots above ground; because trees, if inverted, will put forth *leaves* from the descending caudex, and *roots* from the ascending: so that the branches become roots, and the roots branches. The descending caudex strikes gradually downward into the ground, and is terminated by the *radicula*, or radicles, which are the fibres of the root, acting as so many

many mouths or channels whereby the nourishment is drawn into the body of the root, as into the stomach of man, and thence communicated to the remotest parts.

A root is also distinguished, according to its direction and structure; as *Perpendicular*, when it runs directly downwards. *Horizontal*, when it extends itself transversely under the earth. *Simple*, when it has no subdivisions. *Ramous*, when it is divided into lateral branches. *Fusiform*, when it is oblong, thick, and tapering. *Tuberous*, when it consists of roundish bodies collected into a bunch; and these are either knobbed, palmated, fasciculated, or pendulous. *Repent*, or creeping, when it runs out to a distance, and puts forth radicles from space to space. *Fibrous*, when it consists only of fibres or filaments. *Præmorse*, when the termination is blunt, or not tapering. *Articulate*, when the radicles are jointed. *Dentate*, when formed like teeth. *Bulbous*, when consisting of a bulb; and these are either squamous or scaly, tunicate or coated, globe-shaped, solid, and testiculate or double. In order more completely to illustrate the subject, a correct figure of each of these roots is given in the annexed Botanical Plate I. Fig. 3. is a fibrous root, consisting of filaments only, as in vernal grass. 4. A ramous root, which, like the trees and shrubs, subdivides into branching fibres. 5. A fusiform or spindle-shaped root, gradually lessening downward, as spring raddish. 6. A præmorse root, as if bitten off, when the lower part is truncate, and the termination not tapering; as in plantain, scabious, and valerian. 7. A repent or creeping root, creeping horizontally under ground, as the flowering rush. 8. An articulated or jointed root, divided into joints, as couch-grass. 9. A dentated root, composed of articulations like teeth, as toothwort. 10. A tuberous root, carnosous or knobby, connected together by slender fibres, as piony. 11. A fasciculated root,

fleshy and sessile at the base of the footstalk of the leaves, as *ranunculus*. 12. A palmated root, shaped like a hand, as broad-leaved orchis. 13. A granulated pendulous root, having grain-like substances dispersed on the fibres, as wood-forrel. 14. A squamous or scaly bulbous root, as white lily. 15. A tunicated or coated bulbous root, as daffodil, and onion. 16. A globe-shaped solid bulbous root, as the butter-cup. 17. A testiculated, two-lobed, or double bulbous root, as two-leaved orchis.

OF THE TRUNK OR STEM.

The trunk, or stem, is that part of a plant arising out of the root, and which sustains the leaves, flowers, fruits, &c. Like the root, it consists of three parts, viz. the bark, wood, and pith. These parts, though substantially the same in the trunk as in the root, are in many cases very different in their texture and appearance. The skin of the bark of the trunk is composed of very minute bladders, interspersed with longitudinal woody fibres, as in the nettle, thistle, and most herbs. The outside of the skin is visibly porous in some plants, particularly the cane. The principal body of the bark is composed of parenchyma, and innumerable vessels much larger than those of the skin. The texture of the pulpy part, though the same substance with the parenchyma in roots; yet seldom appears in the form of rays running towards the pith; and when they do appear, they do not extend above half-way to the circumference. The vessels of the bark are very differently situated, and destined for various purposes in different plants. For example, in the bark of the pine, the inmost are lymphducts, and exceedingly small: the outmost are gum or resiniferous vessels, destined for the secretion of turpentine; and are so large as to be distinctly visible to the naked eye.

The wood lies between the bark and the pith, and consists

consists of a parenchymatous and a ligneous part. In all trees, the parenchymatous part of the wood, though much diversified as to size and consistence, is uniformly disposed in diametrical rays, or insertions, running betwixt similar rays of the ligneous part. The true wood is nothing but a congeries of old dried lymph-ducts. Between the bark and the wood a new ring of these ducts is formed every year, which gradually loses its softness as the cold season approaches, and towards the middle of winter is condensed into a solid ring of wood. These annual rings, which are distinctly visible in most trees when cut through, serve as natural marks to distinguish their age. The rings of one year are sometimes larger, sometimes less, than those of another, probably owing to the favourableness or unfavourableness of the season.

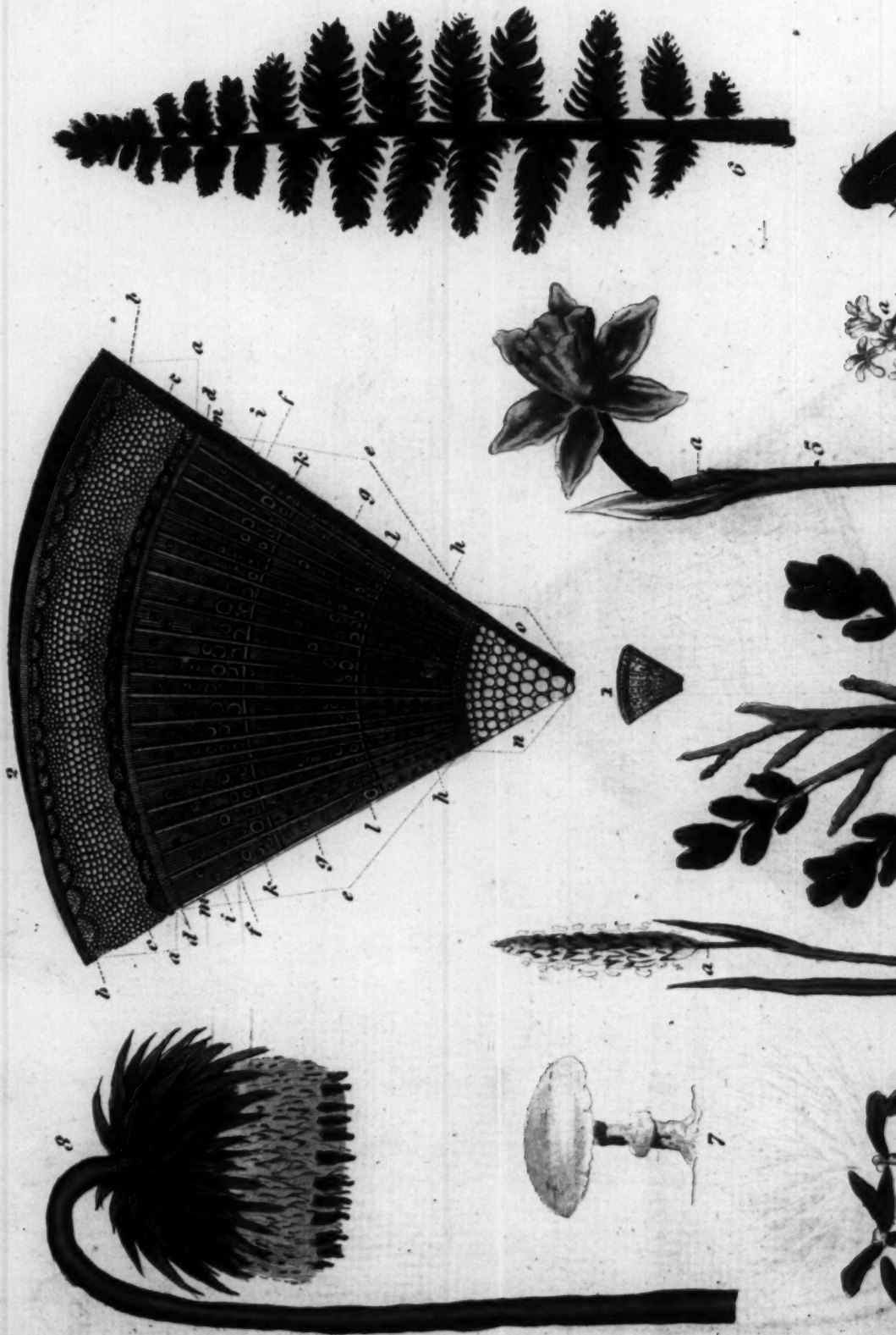
The pith, though of a different texture, is exactly of the same substance with the parenchyma of the bark, and the insertions of the wood. The quantity of pith is various in different plants. Instead of being increased every year like the wood, it is annually diminished, its vessels drying up, and assuming the appearance and structure of wood; insomuch that in old trees there is scarcely such a thing as pith to be discerned. A ring of sap-vessels is usually placed at the outer edge of the pith, next the wood. In the pine, fig, and walnut, they are very large. The parenchyma of the pith is composed of small cells or bladders, of the same kind with those of the bark, only of a larger size. The general figure of these bladders is circular; but in some plants, as the thistle and borage, they are angular. Though the pith is originally one connected chain of bladders, yet as the plant grows old they shrivel, and open in different directions. In the walnut, after a certain age, it appears in the form of a regular transverse hollow division. In some plants it is altogether wanting; in others, as the sonchus, nettle, &c. there is only a

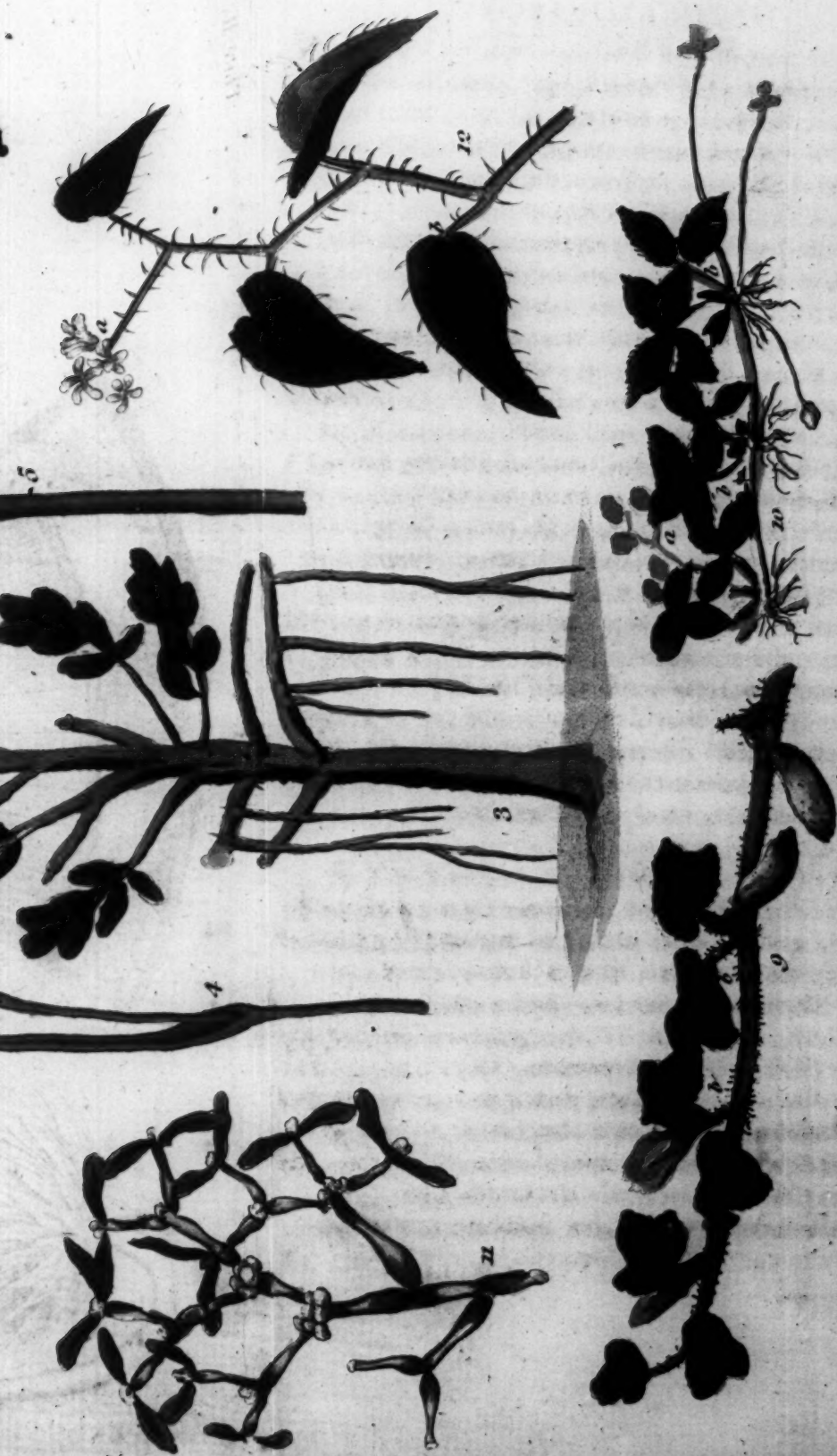
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transverse partition of it at every joint. These curious properties of the trunk are represented in the Botanical Plate II. where fig. 1. shows a transverse section of a branch of *Fraxinus*, or ash, as it appears to the eye. Fig. 2. represents the same section magnified; *a a*, the bark; *b b*, an arched ring of sap-vessels next the skin; *c c*, the parenchyma of the bark with its cells, and another arched ring of sap-vessels; *d d*, a circular line of lymph-ducts immediately below the above arched ring; *e e*, the wood; *f*, the first year's growth; *g*, the second; *h*, the third year's growth; *i i*, the true wood; *k k*, the great air-vessels; *l l*, the small ones; *m m*, the parenchymatous insertions of the bark represented by the white rays; *n, o*, the pith, with its bladders or cells.

The trunk, botanically considered, is of seven different kinds, viz. *caulis*, *culmus*, *scapus*, *pedunculus*, *petiolus*, *frons*, and *stipes*. *Caulis*, a stem, is the proper trunk of a tree or herb, which serves to elevate the leaves and fructification; and is either simple, or compound. Simple stems are such as proceed in a continued series towards their summits: compound are such as are subdivided into small ramuli or branches, and diminish as they ascend. *Culmus*, a straw, is the proper stem of grasses, oats, barley, wheat, &c. and elevates both the leaves and the fructification. *Scapus*, a stalk, is an universal trunk, raising the fructification, but not the leaves, as in daffodil, winter green, lily of the valley, &c. *Pedunculus*, a peduncle, or footstalk of a flower, is a partial trunk, serving to unite the flowers with the root, stem, stalk, or branch, of the proper plant or tree to which they respectively belong. *Petiolus*, a petiole, or footstalk of a leaf, is a species of trunk that fastens the leaves, but not the fructification; a circumstance which distinguishes it from a peduncle. There are some cases where the fructification and leaves are borne on the same footstalk, as in nettle-leaved





The different kinds of Frankish and German. N.º

Face only.

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leaved cistus, and Syrian mallow; but these instances are very rare. *Frons*, is a species of trunk composed of a branch and leaf blended together, and is frequently united with the fructification. There is no expression answerable to this term in our language. *Frons*, with the ancients, though frequently used in respect to trees in the same sense with *folium*, a leaf; implied, in its proper signification, a part of the wood of the tree with the leaf; or, as we should express it, *a twig with leaves*; and for this reason they never applied the term to the leaves of herbs, which are always called *folia*, but only to those of trees. Linnaeus availed himself of this old distinction to make it a botanical term, expressive of the character of Palms, and Filices or ferns; in the former of which the branches, and in the latter even the stem itself, is an actual leaf. *Stipes*, is used to express the base or trunk of a frons, and is applied only to the palms and ferns, and to the Fungi, or mushrooms. It is used also to express the thread, or fine trunk, that supports the pappus in downy seeds.—In the annexed Plate of Trunks and Stems, fig. 3. is the *caulis*; fig. 4. the *culmus*; fig. 5. the *scapus*; *a a a a*, peduncles; *b b b b*, petioles; fig. 6. the *frons*; fig. 7. the *stipes*.

Trunks are again to be considered with respect to their duration, direction, figure, investment, superficies, composition, and rami; that is, when the branches form a part of the stem.

I. Their DURATION. This is generally according to their texture, and named as follows: *Herbaceous*, or herb-like, an annual stem, perishing every year; as the water-plantain. *Suffruticose*, or half-shrubby, the root permanent, but the branches sometimes withering; as the raspberry. *Fruticose*, both stem and branches woody and abiding, as the currant. *Arboreous*, tree-like, having a solid trunk or stem, firm and durable; as the oak. *Inanis*, or pithy, having a spongy substance; as the elder and holyhock.

II. Their

II. Their DIRECTION, which admits of the following distinctions. *Erect*, straight, or stiff, rising nearly in a perpendicular line; as the lacinated teasel. *Lax*, loose, or easily turning; as the triple-headed pond-weed. *Oblique*, growing awry, neither perpendicular nor horizontal: as the golden rod. *Ascending*, rising upwards, with a curve like an arch; as the garden sage. *Reclinate*, or reclined, bending or inclining downwards; as the bastard-orpine. *Incurved*, or bending inwards; as Solomon's seal. *Nutant*, or nodding, when the top or head turns downward; as the musk thistle, and the nodding amaranth. *Diffuse*, consisting of spreading branches; as the yellow tumitory. *Procumbent*, lying on the ground; as the cucumber. *Rooting*, producing shoots or runners from the roots; as the strawberry. *Sarmentose*, consisting of long shoots or tendrils; as the vine. *Repent*, creeping or trailing on the ground, and occasionally throwing out roots; as the strawberry. *Radicant*, or parasitic, striking roots laterally, and growing into or upon other bodies; as the ivy, and trumpet-flower. *Geniculated*, divided by joints or knots; as the white mistletoe. *Flexious*, waved backwards and forwards from bud to bud; as the common smilax. *Climbing*, trailing and growing round some other body; as the hop. *Voluble*, twining about, and supporting itself upon some twig or branch; as the convolvulus, or bindweed: and these are either *dextrorsum*, twining from the right to the left, according to the motion of the sun, as the hop, and honeysuckle; or *sinistrorsum*, winding from the left to the right, contrary to the sun's motion; as the convolvulus, nightshade, and kidney-bean.—The direction of the *nutant* stem, of the *Carduus nutans*, or musk-thistle, is shown at fig. 8; the *procumbent* stem, or cucumber, at fig. 9; the *rooting* and *repent* stem, or strawberry, at fig. 10; the *geniculated*, or mistletoe stem, at fig. 11; and the *flexious* stem, as *Smilax*, or rough bindweed, at fig. 12, of the Botanical



The different kinds of Cacti and Stems. - N. 2.

London: Published as the Act directs, June 22. 1799 by J. Miller.

J. Miller del.

BOTANY.

Plate III.



nical Plate II. The *climbing dextrorsum*, or hop, is shewn at fig. 13; and the *voluble sinistrorsum*, *Convulvulus*, or bindweed, at fig. 14; of the Botanical Plate III.

III. Their **FIGURE**, which admits of the following varieties. *Teres*, when the stem is round, or of a cylindrical figure; as dandelion. *Semiteres*, half-round, or semi-cylindrical; as the belladonna lily. *Compressed*, or flattened, with the two opposite sides flat; as the water-aloe, or water-soldier. *Anceps*, two edged, flattened, with two sharp sides; as St. John's wort. *Angled*, having the stem of an angular form; as the Oswego tea. Also, *diagonous*, *tetragonous*, *pentagonous*, *polygonous*, having two, three, four, five, or many, angles; and also *triquetrous*, three square, when they have three plane sides; and *triangular*, *quadrangular*, *quintangular*, *multangular*, when they have three, four, five, or many, sides; as the melon-thistle.—See a figure and section of one of these *angular* stems, the cactus hexagonus, in the Botanical Plate III. at fig. 15; and of the melon-thistle, or *many-angled* stem, at fig. 16.

IV. Their **INVESTMENT**; these are either *Nudus*, or naked of leaves, as when the stem is only covered with a smooth skin, and wholly destitute of leaves; as the spurge, swallow-wort, horse-tail, and dodder. *Foliate*, or leafy, when furnished with leaves; as the tree-primrose. *Vaginate*, or sheathed, when the stem is surrounded with spatha at the base of the leaves; as the rhubarb. *Squamous*, when covered with scales; as the prickly polypodium. *Imbricated*, when covered with a close succession of small leaves, placed like tiles on a house; as the great houseleek.—The *foliate* stem, or tree-primrose, is shown at fig. 17; the *vaginate* stem, or rhubarb, at fig. 18; and the *imbricate* stem, or houseleek, at fig. 19.

V. Their **SUPERFICIES**; these are either *Suberous*, with a soft elastic bark; as the cork-tree. *Rimous*,
with

with the bark full of cracks and fissures; as the oak. *Tunicated*, or the bark of the stem coated with skins and membranes; as the birch-tree. *Striate*, or streaked, when the stem is marked with very thin hollow lines; as the wake-robin. *Sulcate*, or furrowed, when the trunk is cut in with broad and deep grooves or channels; as the crowfoot and butter-cup. *Glabrious*, or smooth, when the stems have a slippery, glossy, and smooth, surface; as the water corn-flag. *Scabrous*, or rough, when covered with little projecting points and prominences; as the dwarf sun-flower. *Muricate*, or prickly, when armed with sharp points or prickles; as the cactus paradisica. *Tomentose*, the stem covered with down; as the moth-mullein. *Lanated*, covered with a soft woolly hair; as the Ethiopian sage. *Villous*, or shaggy, covered thickly with hair; as the hairy inula. *Pilose*, covered with hair thinly placed; as the white saxifrage. *Hispid*, covered with stiff bristles; as the lacinated teasel. *Aculeated*, when the stem is armed with strong sharp prickles; as the bramble. *Spinous*, armed with thorns or spines; as the hawthorn, sloe, &c. *Urens*, or stinging, when armed with stings; as the common nettle. *Stipulate*, when supported with leafy props on each side the stem; as the everlasting pea; and this stem, from its stipulate leaves, is also termed *membranaceous*. *Bulbiferous*, the stem bearing small bulbs at the axillas of the leaves: as the bulb bearing lily.—The *muricated* stem is represented at fig. 20; the *lanated*, or Ethiopian sage, at fig. 21; the *hispid*, *Dipsacus laciniatus*, or cut-leaved teasel, at fig. 22; the *aculeated*, or bramble, at fig. 23; and the *bulbiferous*, or bulb-bearing lily, at fig. 24.

VI. The COMPOSITION. This is termed *Enodis*, when composed or made up without joints; as the bulrush. *Simplex*, or simple, when the trunk rises uniform and regular to the top; as in stitchwort. *Simplicissimus*, very simple, when it has few or no branches;

branches; as dog's mercury. *Entire*, when the stem is undivided; as in birthwort. *Articulate*, when the trunk is composed of many pieces or joints; as the Indian fig. *Proliferous*, when the stem sends forth branches only from the apex of the shoots; as the Scotch fir. *Dichotomus*, or forked, branching always into two parts or arms; as the trunk of the white mistletoe. *Brachiate*, or branching opposite, the upper pair crossing the next below; as in yellow cistus. *Subramous*, the stem throwing out but few lateral branches; as lizard's tail. *Ramous*, throwing out many lateral branches; as the stock July-flower. *Ramocissimus*, very branchy, and growing out without order in all directions; as in most trees. *Virgated*, having many slender twigs; as in strawberry-blite. *Paniculated*, when the branches are variously subdivided; as in the wild oat. *Fastigated*, the branches arising from a centre to an equal height; as tooth-leaved androsace. *Patent*, having numerous spreading branches; as in fennel. *Divaricate*, the branches forming an obtuse angle from the trunk; as in the coffee-tree.—The *articulated* trunk, or Indian fig, is shown at fig. 25; the *dichotomus* stem, or white mistletoe, at fig. 11; and the *divaricate*, or coffee-tree, at fig. 26.

VII. RAMI, the branches, forming a part of the stem. They are termed *Alternate*, when they come out single one above another, following in gradual order; as the wolf's-bane, or monk's-hood. *Distich*, in two rows, when the branches grow out in a horizontal direction; as in polypodium, or fern. *Sparsed*, or scattered, when they come out irregularly; as in butcher's broom. *Confert*, when the branches are crowded close together; as in cypress. *Verticillate*, the branches surrounding the trunk like the rays or spokes of a wheel; as in the great water-plantain. *Coarctate*, the branches shooting up perpendicularly close together; as laurus tinus. *Divergent*, the branches

branches growing out far from the trunk, and spreading every way from the same centre ; as the eastern coffee-tree. *Deflexed*, when bending downwards archways ; as the weeping willow. *Reflex*, when turning upwards towards the trunk ; as yellow clusia. *Retroflex*, when bending back towards the trunk ; as the buckthorn. *Fulcrate*, when shooting out roots from the branches for props or supports ; as the Bengal fig.—The *distich* rami of the fern, are shown at fig. 6 ; the *fulcrate*, at fig. 3 ; and the *divergent*, at fig. 26, of the above-mentioned plates.

Of the LEAVES.

The leaves of plants consist of the same substance with that of the trunk. They are full of nerves or woody portions, running in all directions, and branching out into innumerable small threads, interwoven with the parenchyma, like fine lace or gauze. The pulpy or parenchymatous part consists of very minute fibres, wound up into small cells or bladders, which are of various sizes in the same leaf. All leaves, of whatever figure, have a marginal fibre, by which all the rest are bounded. The particular shape of this fibre determines the figure of the leaf. The vessels of the leaves have the appearance of inosculating ; but, when examined by the microscope, they are found only to be interwoven, or laid along each other. What are called *air-vessels*, or those which carry no sap, are visible even to the naked eye in some leaves. When a leaf is slowly broke, they appear like small woolly fibres, connected to both ends of the broken piece.

Linnaeus considers the leaves as the muscles or organs of motion in plants ; other writers call them the organs by which perspiration and inspiration are performed. Some plants have very thick fleshy leaves, whose pulpy substance is always moist : these are such as naturally grow upon dry barren rocks, and are generally

nerally natives of warm countries, which, as they can draw in very little nourishment from the earth, perspire only in a small quantity. The leaves of such plants have a thin compact skin over their surface, with minute pores, which prevent the descending moisture from penetrating into their substance and destroying them. The same structure is also observable in the leaves of those trees and shrubs which retain their verdure all the year; and they are known to imbibe and perspire little moisture in comparison with the deciduous trees and shrubs: moreover, their nutritive juices are of an oily exterior in their own quality, which secures them from the frost. Plants in general are known to receive and transpire more, in equal time, than large animals; hence it appears that the leaves are necessary to preserve the plant both in health and life. It has been found by accurate calculation, and repeated experiments, that *a plant of the sun-flower receives and perspires, in twenty-four hours, seventeen times more than a man.*

It is certain that no plant, to which nature has allotted leaves, can live without them; but will certainly die if they are pulled off as soon as they appear. This confirms the theory of the circulation through their innumerable pores and vessels. The leaves of rue seem full of holes, like a honey-comb; all the kinds of St. John's wort appear likewise stuck full of pin-holes to the naked eye, but the microscope discovers, that the places where these holes seem to be, are really covered with a very thin and white membrane. The under side of the herb mercury looks as if rough-cast with silver, and all the ribs are full of white, round, transparent balls, fastened by silken filaments, like so many grapes. A sage-leaf appears like a rug, or shag, beset with tufts of silver thrums, and embellished with fine round crystal beads, or pendants, fastened by slender foot-stalks. The under side of a rose-leaf, and particularly that of the sweet-

briar, appears diapered with silver. Every one knows, that the leaves of stinging-nettle are thick set with sharp prickles, which penetrate the skin when touched, and occasion heat, pain, and swelling. These symptoms were imagined formerly to be owing to the prickles being left in the wound; but the microscope discovers something much more wonderful in this plant, and shows that its prickles are formed for acting, in the same manner as the stings of animals; for every one of them is found to be a rigid body, hollow, and terminating in a very fine point, with an opening near its end. At the bottom of this prickle there lies a pellucid bag, containing a limpid liquor, which, upon the least touching of the prickle, is injected through the skin, and produces pain and irritation by the pungency of its salts. See Baker on the Microscope, p. 259. The figure of the leaves of plants may be represented by holding one in the smoke of resin, camphor, a candle, &c. whereby the leaf acquires a blackness, which, when pressed on white paper, gives the exact size, shape, and particular ramifications, of the fibres. This method may be of use to botanists, when they have no skill in drawing. See Boyle's Works, abr. vol. i. p. 132.

The structure and diversity of leaves, have given occasion to their being divided into three classes; viz. *simple*, *compound*, and *determinate*.

I. **SIMPLE LEAVES.** These are such as have only a single leaf on a petiole; but differ in respect to circumscription, angles, sinuses, apices, margin, superficies, and substance; by which properties their characters are respectively distinguished and known. **CIRCUMSCRIPTION** implies the form of the circumference of leaves, when there are no angles or sinuosities; in which respect leaves are, *Orbicular*, or round, when the longitudinal and transverse diameters are equal, and the circumference circular. *Subrotund*, or roundish, when the figure is nearly orbicular.

Ovate,

Ovate, or egg-shaped, when the longitudinal diameter exceeds the transverse; and the base is circumscribed with the segment of a circle, but the apex narrower. *Oval*, or elliptic, when the longitudinal diameter exceeds the transverse, and the circumscription of both upper and lower extremity is narrower than the segment of a circle. *Parabolic*, in the form of a parabola, when the longitudinal diameter exceeds the transverse, and the figure contracting from the base upward becomes *Semiovate*, or half egg-shaped. *Spatulate*, resembling a spatula, when the figure is roundish, but lengthened out by the addition of a linear base that is narrower. *Cuneiform*, or wedge-shaped, when the longitudinal diameter exceeds the transverse, and the figure gradually contracts downwards. *Oblong*, when the longitudinal diameter is twice, thrice, &c. the length of the transverse, and the circumscription of each of the extremities is narrower than the segment of a circle.

ANGLES, are the prominent parts of an horizontal leaf. In respect to these, a leaf is said to be, *Lanceolate*, or spear-shaped, when the figure is oblong, narrowing gradually at each end towards the extremity. *Linear*, when it is every-where of the same breadth, though sometimes narrowing at the extremities only. *Acerose*, or chaffy, when it is linear and persisting; as in the cypress, juniper, and yew. *Subulate*, or awl-shaped, when it is linear below, but gradually contracting towards the top. *Triangular*, or three-cornered, when the disk is surrounded by three prominent angles. *Quadrangular*, *Quinquangular*, &c. four-cornered, five-cornered, &c. when four or five prominent angles lie round the disk. *Deltoid*, when the figure is a rhomb; that is, having four angles, of which the two lateral ones are less distant from the centre than those at the extremities. *Rotund*, or round, when it has no angles.

SINUS, a hollow, is a term used to express those openings

openings or cavities in leaves which distinguish them into parts: in respect to these, leaves are said to be, *Reniform*, or kidney-shaped, when they are roundish, and hollowed at the base, without any angles. *Cordiform*, or heart-shaped, when they are ovate, and hollowed at the base, and the hinder or lower part has no angles. *Lunulate*, or moon-shaped, when they are round, and hollowed at the base, and the lower part has no angles. *Sagittate*, or arrow-shaped, when they are triangular, hollowed at the base, and are furnished with angles at the lower part. *Hastate*, or javelin-shaped, when they are triangular, the base and sides hollowed, and the angles spreading. *Panduræform*, or fiddle-shaped, when they are oblong, broader above than below, and contracted in the sides. *Fissa*, or cloven, when they are divided by linear sinusses, and have their margins straight; and from the number of such divisions they are called *Bifid*, *Trifid*, *Quadrifid*, *Multifid*, &c. when cut into two, three, four, five, or many, segments. *Lobate*, or lobed, when they are divided to the middle into parts that stand wide from each other, and have their margins convex; and from the number of these they are called *Bilobe*, *Trilobe*, *Quadrilobe*, or *Quinquelobe*; consisting of two, three, four, or five, lobes. *Palmate*, or hand-shaped, when they are cut longitudinally into many parts nearly equal; the divisions extending themselves downward, almost to the base where the segments cohere. *Pinnatifid*, or cut into wings, when they are divided transversely into laciniae that are oblong and horizontal. *Lyrate*, or lyre-shaped, when they are divided transversely into laciniae, of which the upper ones are larger, and the lower ones farther asunder. *Laciniate*, or jagged, when they are variously divided into parts, and those parts in like manner indeterminately subdivided. *Sinuate*, or hollowed, when they have broad and spreading openings in the sides. *Partite*, or divided, when they are separated down to the base;
and

and from the number of divisions they are called *Bipartite*, *Tripartite*, *Quadripartite*, *Quinquupartite*, or *Multipartite*; divided into two, three, four, five, or many, parts. *Integra*, or entire, when they are without divisions, and have no sinus or opening. This stands opposed to all the kinds of divided leaves before described.

APEX, the tip, is the extremity where the leaf terminates. Leaves, in respect to their apices, are called, *Truncate*, or lopped, when they end in a transverse line. *Præmorse*, as if bitten in the fore-part, when they are very obtuse, and are terminated by unequal notches or incisions. *Retuse*, or blunted, when they terminate in an obtuse sinus. *Emarginate*, or nicked, when they terminate in a notch. *Obtuse*, or blunt, when they terminate as it were within a segment of a circle. *Acute*, or sharp, when they terminate in an acute angle. *Acuminate*, or pointed, when they terminate in a subulate apex. *Cirrhone*, or clasped, when they terminate in a clasper or tendril; as in the superb lily, flagellaria, and nissolia.

The **MARGIN** of a leaf is the outermost boundary of its sides, exclusive of its disk. Leaves, in respect to their margin, are called *Spinose*, or thorny, or prickly, when the margin runs into points that are hard, stiff, and pungent. *Inerm*, unarmed, or smooth; which is opposed to spinose. *Dentate*, toothed, or indented, when the margin ends in horizontal points, that are of the consistence of the leaf, and are separated by intermediate spaces. *Serrate*, or sawed, when the margin is cut into sharp imbricate angles, that point towards the apex of the leaf. If they point towards the base, the leaf is said to be *retrosum-ferrate*, or sawed backwards. *Duplicato-serrate*, or doubly-sawed, when there is a two-fold serrature, the less upon the greater. *Crenate*, or notched, when the margin is cut into angles, that point towards neither of the extremities; and these are obtusely crenate,

nate, when the angles are rounded; or acutely crenate, when the angles are pointed. *Duplicato-crenate*, or doubly notched, when the notches are two-fold, the less upon the greater. *Repand*, or bending back again, when the margin is terminated with angles, and interjacent sinusses, that are both inscribed with the segments of circles, forming a serpentine edge. *Cartilaginous*, or gristly, when the edge of the leaf is strengthened by a tough border, the substance of which differs from that of the leaf. *Ciliate*, dashed, or fringed, when the margin is surrounded on all sides with parallel bristles. *Lacerate*, rent, or ragged, when they are irregularly cut on the margin, unlike segments. *Erosc*, or gnawed, when the leaf is sinuate, and has other very small obtuse sinusses or hollows on its margin. *Integerrimate*, or very entire, when the outermost margin is entire and quite free from notches.

SUPERFICIES, or surface, is the outside, or what covers the disk of the leaf; and respects both the supine disk or face of the leaf, and the prone disk or back of it. Leaves in respect to their surfaces are, *Viscid*, or clammy, when they are covered with a juice that is tenacious or sticky. *Tomentose*, or downy, when they are covered with a nap of interwoven hairs, scarcely perceptible, that gives them a whiteness. *Lanate*, or woolly, when they are covered as it were with a spider's web; as in sage and iron-wort. *Pilous*, or hairy, when their surface is covered with distinct hairs that rise to some length. *Hirsute*, or rough with hair, when they are hairy in a greater degree. *Villous*, or shaggy, when they are covered with a coarser hair or shag. *Hispid*, or rough, when the disk is covered with a stiffish sort of bristles that are frangible. *Scabrous*, or rugged, when the disk is covered with tubercles, or little knobs. *Aculeate*, or prickly, when the disk is beset with points that are sharp and stiff. *Striate*, or streaked, when the surface

is cut in, or scored longitudinally with parallel lines. *Papillous*, or nippy, when it is covered with vesicles, like little bladders. *Punctate*, or dotted, when it is besprinkled with hollow points or dots. *Nitid*, or bright, when the smoothness of the leaves causes them to shine. *Plicate*, or plaited, when the disk of the leaf rises and falls in angles towards the margin; as lady's mantle. *Undulate*, or waved, when the disk of the leaf rises and falls in convexities towards the margin. *Crisped*, or curled, when the circumference of the leaf becomes larger than the disk admits of, and is thereby forced to undulate. All curled leaves are ranked as monsters. *Rugous*, or wrinkled, when the veins of the leaves contract into a narrower compass than the disk, so that the substance between them is obliged to rise; as in sage. *Concave*, or hollow, when the margin of the leaf contracts, and becomes less than the circumscription of the disk, by which means the disk is depressed. *Vinous*, or veiny, when the vessels are branched all over the leaves, and their anastomoses or joinings are obvious to the naked eye. *Nervous*, when they have simple unbranched vessels, that extend themselves from the base to the apex. *Coloured*, when they change their green for some other colour; as in tri-coloured amaranth. *Glabrous*, or smooth, when the surface is void of all inequality.

The SUBSTANCE of a leaf respects the conditions of its sides: in this respect leaves are, *Teretes*, or round like a pillar, when they are for the most part cylindric. *Semi-cylindric*, like a halved cylinder, when they are round on one side, and flat on the other. *Tubulous*, like a tube or pipe, when upon cutting them they appear to be hollow within. *Carnous*, fleshy, or succulent, when they are filled with a pulp. *Compressed*, or flatted, when they are so compressed by their opposite marginal sides, that the substance of the leaf becomes greater than the disk. *Plane*, or level, when they have both surfaces every where

parallel. *Gibbous*, or bunched, when by a plenitude of pulp both the surfaces are rendered convex. *Convex*, or rounding, when the disk rises higher than the sides. *Deprest*, or pressed down, when the sides rise higher than the disk. *Canaliculate*, or channeled, when a deep furrow runs along it, and sinks it almost to a half-cylinder. *Adcipites*, or double-faced, when the disk is convex, and there are two prominent longitudinal angles. *Ensiform*, or sword-shaped, when they grow narrower from the base to the apex. *Acinaciform*, faulchion or scimitar shaped, when they are fleshy and compressed, with one edge convex and narrow, and the other straighter and broader. *Dolabriform*, or hatchet-shaped, when their figure is roundish, compressed, and obtuse; gibbous outwardly with a sharp edge, and taper towards the lower part. *Lingueform*, or tongue-shaped, when they are linear, fleshy, obtuse, convex underneath, and often with a cartilaginous margin. *Triquetrous*, or three-cornered, when they are subulate, and have three flat longitudinal sides. *Sulcate*, or furrowed, when they are scored longitudinally with numerous angles or ridges, and as many hollows or channels betwixt them. *Carinate*, or keeled, when the prone part of the disk is prominent longitudinally. *Membranaceous*, when they have no perceptible pulp between the two surfaces.

II. COMPOUND LEAVES.—A leaf is said to be compound, when there are more than one upon a petiole or footstalk; and these are to be considered in respect to *Structure*, and *Degree*. By their *STRUCTURE*, is to be understood the insertion of the folioles, or little leaves, of which they are compounded; and in this respect leaves are called, *Compound*, when a single petiole furnishes more than one leaf. *Articulate*, or jointed, when one leaf grows out at the top of another. *Digitate*, or fingered, when the apex of a single petiole connects many folioles; and they are termed *Binate*, *Ternate*, or *Quinate*, growing two, three,

three, or five, together, according to the number of folioles of which the digitate leaf consists. *Pinnate*, or winged, when the sides of a single petiole connect many folioles. *Pinnate* with an odd one, when it is terminated by an odd foliole. A *Cirrhose* pinnate leaf, when it terminates in a cirrhous or clasper. An *Abrupt* pinnate leaf, when it is terminated neither by a foliole nor cirrhous. *Oppositely* pinnate, when the folioles stand opposite to each other. *Alternately* pinnate, when the folioles are produced alternately. *Interruptedly* pinnate, when the folioles are alternately less. *Articulately* pinnate, when the petiole common to all the folioles is articulate, or jointed. *Decursively* pinnate, when the folioles are decurrent, or running down; that is, extending themselves downward along the petiole. *Conjugate*, when the pinnate leaf consists of two folioles only.

DEGREE, in a compound leaf, respects the subdivisions of the common petiole. In respect to which, leaves are; *Decomposed*, when a petiole once divided connects many folioles. *Bigeminate*, when a dichotomous petiole connects four folioles on its apices. *Biternate*, or *Duplicato-ternate*, when there are three folioles on a petiole, and each foliole is ternate, as in barren-wort. *Bipinnate*, or *Duplicato-pinnate*, when the folioles of a pinnate leaf are pinnate. *Pedate*, foot-shaped, or branching, when a bifid petiole connects many folioles on its inside only; as in passion-flower and wake-robin. *Supra-decomposed*, when many folioles are borne on a petiole that has been any number of times subdivided. *Triternate*, or *Triplicato-ternate*, when a petiole bears three folioles that are each of them ternate. *Tripinnate*, or *Triplicato-pinnate*, when a petiole bears many folioles, each of which are bipinnate.

III. DETERMINATE LEAVES.—By the DETERMINATION of leaves is to be understood their character expressed from some circumstance foreign to their own particular structure or configuration; as

from their *Place, Situation, Insertion, or Direction*. By the *PLACE* of a leaf is meant the part where it is fastened to the plant. In respect to which, leaves are called, *Seminal*, or seed-leaves, which before were the cotyledons, or lobes of the seed, and are the first which appear. *Radical*, or root-leaves, such as proceed from the root. *Cauline*, or stem-leaves, such as grow on the stem. *Ramous*, or branch-leaves, such as grow on the branches. *Axillary* leaves, such as are placed at the coming-out of the branches. *Floral*, or flower-leaves, such as are placed at the coming-out of the flower.

By *SITUATION*, is meant the disposition of the leaves on the stem of the plant. In respect to which, leaves are called, *Stellate*, starry, or *Verticillate*, whirled, when the stalk is surrounded in whirls by more than two leaves: and these again receive the denomination of *Tern*, *Quatern*, *Quine*, *Sené*, &c. according to the number of leaves of which the star or whirl is composed; as in rose-bay, African almond, and mare's-tail. *Opposite*, when the cauline leaves come out in pairs facing each other, and each pair is crossed by the next, so that they point four different ways. *Alternate*, when they come out singly, and follow in a gradual order. *Sparsed*, or scattered, when they come out numerously about the plant, without order. *Consert*, or crowded, when they come out in quantities, so as almost to cover the branches, and leave hardly any space between them. *Imbricate*, when they are consert and erect, so as to lie over one another, each covering a part of the following one. *Fasciculate*, or bundled, when many come out from the same point. *Distich*, in two rows, when the leaves all spring out from two sides of the branches only.

In respect to their *INSERTION*, (which is usually at the base,) leaves are called, *Peltate*, or shield-fashioned, when the petiole is inserted into the disk of the leaf, and not into its base or margin; as in water-lily.

water-lily. *Petiolate*, when there is a petiole fastened to the leaf at the margin of the base. *Sessile*, or squat, when the leaf has no petiole, but is fastened immediately to the stem. *Decurrent*, or running down, when the base of a sessile leaf extends itself downwards along the stem, beyond the proper base or termination of the leaf; as in the globe-flower, and thistle. *Amplexicaul*, or embracing the stalk, when the base of the leaf embraces the sides of the stem crosswise on both sides; or *Semi amplexicaul*, embracing the stalk in a less degree. *Perfoliate*, when the base of the leaf is continued across the stem till it meets again, so as to embrace it all round; as in hare's-ear. *Connate*, or growing together, when two opposite leaves join, and are united in one; as in hemp-agrimony, and honey-suckle. *Vaginant*, forming a vagina or sheath, when the base of the leaf forms a cylindric tube that invests the branch.

In respect to their DIRECTION, leaves are called *Adverse*, when their sides are not turned towards the sky, but towards the horizon; as in ginger. *Oblique*, when the base of the leaf looks towards the sky, and the apex or tip towards the horizon; as in the silver-tree, and crown imperial. *Inflex*, or bending inwards, when the leaf is bowed upwards towards the stem. *Adpress*, when the disk of the leaf lies close to the stem. *Erect*, or upright, when the angle they form with the stem is extremely small. *Patent*, or spreading, when they make an acute angle with the stem. *Horizontal*, when they stand at right angles with the stem. *Reclined*, or, as some term it, *Reflex*, when they are bowed downwards, so that the apex or tip is lower than the base. *Revolute*, or rolled back, when they are rolled downwards. *Dependent*, or hanging down, when they point directly to the ground. *Radicant*, or rooting, when the leaves throw out roots. *Natant*, or floating, when they lie on the surface of the water; as in pond-weed, and the water-lily.

lily. *Demerſe*, or ſunk, when they creep and grow under the water.—Theſe are the diſtinctions which modern Botany has aſſigned to the different kinds of leaves. But to explain this ſubject ſtill more completely, we ſhall ſubjoin correct engravings of the Linnæan arrangement, from the accurate and elegant deſigns of Mr. John Miller; following the alphabetical order in which he has placed them.

Figures of the Simple Leaves.

PLATE IV. Fig. 1. *Acerofe*, the leaves everywhere of the ſame breadth; as in the pines, or Scotch fir.

2. *Acinaciform*, or ſcimitar-shaped, as in fig-marigold.

3. *Aculeated*, ſharp-pointed or prickly, as the annual Barbadoes night-ſhade.

4. *Acuminated*, tapering or terminating in a point, as the leaves of the Malabar fig.—*Acute*, terminating in an acute angle, as the leaves at fig. 4, 43, 51, 52, and 55.

5. *Anceps*, double-edged; forming two oppoſite angles lengthways, the diſk being convex, as in *Bermudiana*.

6. *Bearded*; a tuft of briftly hairs terminating the leaf, as in beaded fig-marigold.

7. *Bifid*, divided into two parts, by linear ſinufes and ſtraight margins, as in climbing mountain-ebony: alſo *trifid*, *quadrifid*, *quinquifid*, and *multifid*, according to the number of its diviſions.

8. *Bullated*, when the ſubſtance of the leaf riſes high above the veins, ſo as to appear like *rugæ* or bliſters; as the green tea.

9. *Channelled*, having a deep groove or channel running from the baſe to the apex, as in Virginian ſpider-wort.

10. *Carinated*, or keel-shaped; the inferior diſk or back





Simple Leaves—N^o 1.

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back of the leaf resembling somewhat the keel of a ship; as the distich aloe.

11. Carnous, or fleshy; being internally replete with a pulp or fleshy substance; as the greater house-leek.

12. Cartilaginous, the margin strengthened by a cartilaginous substance different from the disk; as the pyramidal saxifrage.—Ciliated, whose margin is guarded by parallel bristles, formed like the eye-lash; see fig. 11.

13. Cirrhous, the point terminating in a tendril; as the superb lily.

14. Coloured, when leaves deviate from the natural green, and put forth other tints; as the tri-coloured amaranth.

15. Compressed, when flattened on its marginal sides, and the substance of the leaf becomes greater in the disk; as fig-marigold with variegated leaves.

16. Convex, when the margin forms a concave arch with the disk; as in peltated geranium.

17. Concave, rising in the reverse order from the margin to the disk; as perennial Martynia.

18. Cordated, or heart-shaped, hollowed at the base, and destitute of angles; as black bryony.

19. Cordated obversely, when a heart-shaped leaf is fixed by the apex instead of the base, to the petiole or footstalk; as wood-forrel.

20. Cordate and sagittate; as the leaf of buck-wheat.

21. Crenated, or notched, the margin being jagged with small teeth or angles, inclining towards neither extremity; as wood-betony.

22. Crispid, undulated from the circumference of the margin, being too long for the disk; as curled malva. All leaves of this description are termed *monstrous*.

23. Cucullated, rolled up lengthways, in form of a hood or cowl; as the African-tree crane's bill.

24. Cuneiform,

24. Cuneiform, or wedge-shaped, when the length exceeds the breadth, gradually narrowing towards the base; as in purslain-leaved *crassula*. — Cuspidate, sharp-pointed, the apex terminating in a point like a spear; as shown at fig. 4, and 43.

25. Cylindrical, in form of a cylinder or roller, as the hispid fig-marigold.

26. Dedaleous, leaves whose texture is remarkably beautiful, and exquisitely wrought; as stoloniferous saxifrage, and beautiful *Alstroemeria*.

27. Deltoid, leaves whose angles are formed like the Greek delta Δ ; as the delta-shaped fig-marigold, and the sea-purslain tree.

28. Dentated, having horizontal points like the teeth of a saw, of the same consistence as the leaf, and placed at a little distance from each other; as in strawberry-blite.

29. Depressed, when the centre of the leaf is pressed inwards, and the sides rise higher than the disk; as in fig-marigold with deformed leaves.

30. Dolabriform; compressed, subrotund, and obtuse; the under side roundish, in the shape of a hatchet, or axe; as the hatchet-shaped fig-marigold.

31. Echinated, or prickly, beset all over with aculi or prickles, like a hedgehog; as the *ilex echinatum*, or hedgehog-holly. — Elliptic, when the longitudinal diameter surpasses the transverse, and the leaf narrows almost equally at the base and apex, as shown at fig. 59. — Emarginate, when the apex of the leaf terminates in a notch, as in fig. 24.

32. Emarginated acutely, when the notch is deep and narrow; as the silver fir.

33. Emarginated obtusely, when the sides are rounded from the apex; as alder-leaved *Hermannia*.

34. Emarginated circularly, when notched all round; as in the water navel-wort.

35. Ensisiform, shaped like a two-edged sword, tapering

pering gradually towards the point; as in *aletris uvaria*.

36. *Erosc*, when a sinuated leaf has its margin broken by smaller sinuses; as the shrubby African sage.

37. *Gibbous*, bunching out, or *gouty*; when, by means of the intermediate pulp, both surfaces of the leaf are rendered convex; as in *cacalia ficoides*, or foreign coltsfoot.

38. *Glabrous*, or smooth, when the surface of the leaf is all over smooth and even; as the orange-tree.

39. *Hastated*, growing in a triangular form, the lateral base hollowed, and the angles spreading out, resembling the head of an halbert; as in *cacalia suaveolens*, the American coltsfoot.

40. *Hirsute*, rough, hairy, and shaggy in the disk; as the leaves of hollyhock.—*Hispid*, covered irregularly with strong fragile bristles on the disk; as shown at fig. 25.

41. *Integrum*, or entire, when the margin of the leaf is perfectly even, and free from crenules or notches; as broad-leaved orchis.

42. *Lacerated*, when the margin is variously cut with irregular segments, as if rent or torn; as in the American groundsel.—*Lanated*, when the surface of the leaf appears of a cottony or woolly texture, as if covered over with a spider's web; as in shrubby African sage, fig. 36.

43. *Lanceolated*, or lance-shaped, when the leaf is oblong, gradually tapering towards the extremity, and terminating in a point; as dog's-bane.

44. *Laciniated*, divided first into *laciniae* or segments, and those again irregularly cut into small incisions; as the bee larkspur.

45. *Linear*, the lateral margins parallel, narrowing a little towards the apex; as the belladonna, or daffodil lily. *Lineated*, the superficies slightly streaked or marked longitudinally with parallel lines, not impress-

ing the surface; as shown in the leaf of superb lily, at fig. 13.

46. Linguiform, or tongue-shaped, when the leaf is linear and carnosous, obtuse and convex on the under side, the margin sometimes cartilaginous; as in distich aloe.

47. Lobated, or gashed, when the leaf is divided to the middle into distinct lobes having their margins convex; as the common maple.

48. Lunated, or moon shaped, when the leaves are subrotund, and hollowed at the base in the form of a crescent; as the Domingo passion-flower.

49. Lucid; all such leaves as are bright, shining, or glossy, and, as it were, reflecting light; as the laurel, bay, &c.

50. Lyrated, or lyre-shaped, divided transversely into segments, the upper ones being larger, and the inferior distant from each other; as in hedge-mustard. —Maculated, marked with spots of a different colour from the leaf, yet smooth and even with the superficies, as shown in the orchis-leaf, fig. 41.

51. Membranaceous, having no distinguishable pulp between the membranes of the two surfaces; as the Indian reed.

52. Mucronated, or dagger-shaped, the leaf terminating in a sharp-point; as in Tartarian thrift.

53. Mucronated obtusely, the leaf having a sharp-pointed apex, with rounded sides; as Canadian asarabacca.

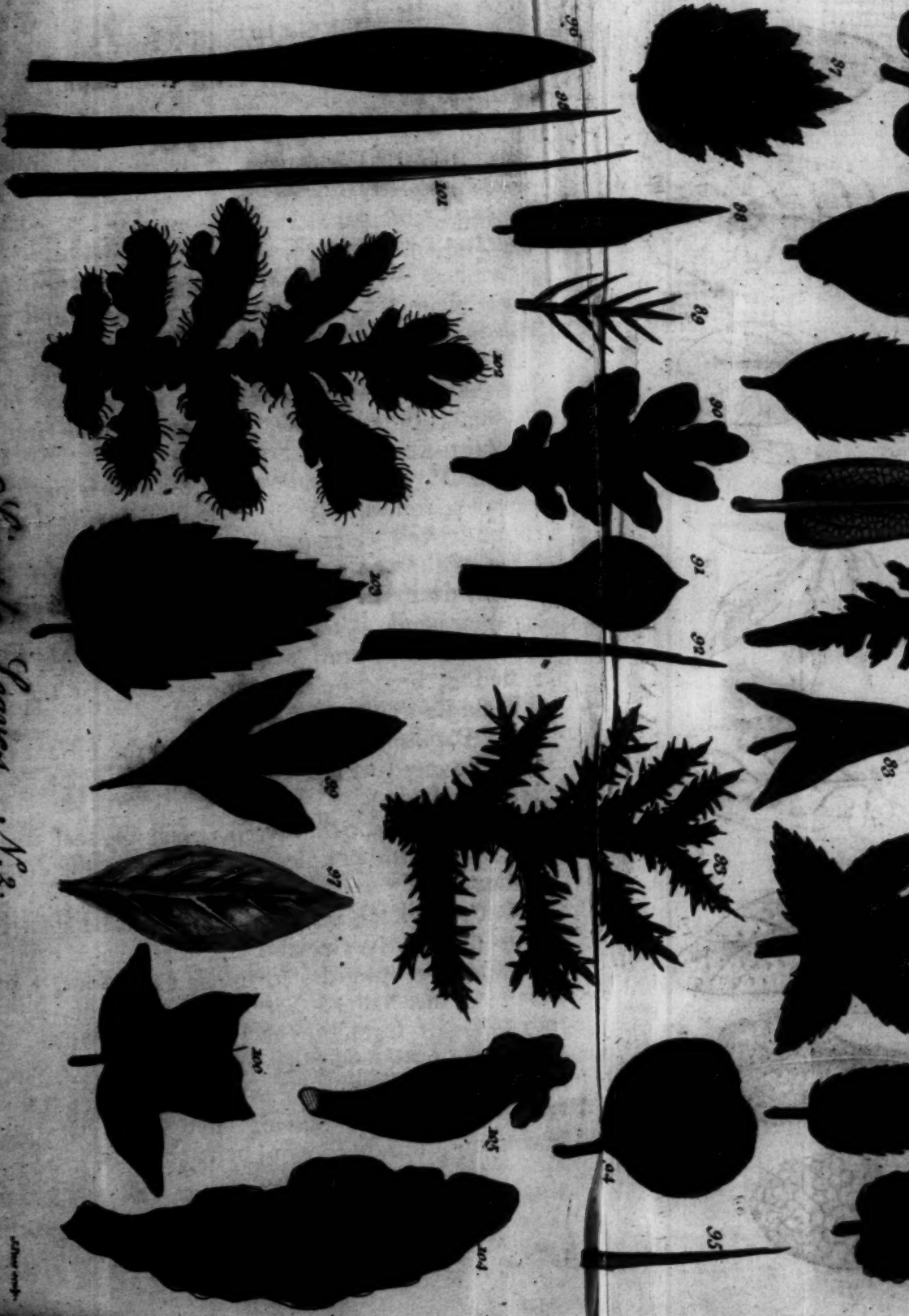
54. Multipartite, when a leaf is divided into many distinct parts or segments; as wolf's-bane or monk's-hood.

55. Nervous; leaves whose surfaces are full of nerves or fibres, extending from the base to the apex; as the great water-plantain.

56. Oblong; leaves whose longitudinal diameter is several times longer than the transverse, both extremities being rounded, but narrower than the segments

Simple Leaves. N. 2.

For the purpose of illustrating the different shapes and textures of simple leaves.



For the purpose of illustrating the different shapes and textures of simple leaves.

BOTANY.

Plate V.



ments of a circle; as the burning thorny plant or spurge.

57. Obtuse; leaves blunt at the apex, but rounded elliptically or less than a circle; as in the obtuse-leaved pepper.

58. Orbicular; the leaf forming a circle; as in the Indian cress.

PLATE V. Fig. 59. Oval; leaves whose longitudinal diameter surpasses the transverse, and are narrowed at both extremities; as the American mame.

60. Ovate, when the longitudinal diameter is longer than the transverse, and the segment of the base circumscribing a circle, the apex of the same form, but narrower; as the South-Sea tea.

61. Obversely ovate, when the base is narrow, and the apex round, like an ovate leaf inverted; as the round-leaved water-pimpernel.

62. Palmated, or hand-shaped, the leaf having several divisions almost to the base, spreading like an open hand, as the common passion-flower.

63. Panduriform, or fiddle-shaped, when the leaf is oblong, broad below, and narrowed at the sides; as in fiddle-dock.

64. Papillous, or nippy; when the surface of the leaf is covered with dots or points like nipples; as in viper's bugloss.

65. Papulous, or blistered, when the leaf is overspread with little pimples or blisters; as the diamond ficoidea.

66. Parabolical, when the longitudinal diameter exceeds the transverse, and the leaf grows narrower from the base upwards, forming, as it were, a parabola; as the bastard horehound.—Partite, divided into lobes or segments; as bipartite, tripartite, quadripartite, quinquepartite, multipartite, according to the number of divisions; as in fig. 42, 44, 54, &c.

67. Pentangular, having five prominent angles surrounding the disk; as in peltated crane's-bill.

68. Perforated, or pierced, having holes or perforations through the disk ; as in perforated draconium.

69. Pilous, or hairy, the leaf being covered with long distinct hairs ; as in the hairy Pyrenean hawk-weed.

70. Pinnatifid, or winged ; the leaf being divided into long horizontal transverse laciniae ; as in the pinnatifid star-thistle.

71. Planum, or plane ; leaves whose surface is quite flat, free from any pulpy swelling, and neither concave nor convex ; as broad-leaved ruscus.

72. Plicated, or plaited, the leaf being doubled or folded ; as the white hellebore.

73. Præmorse, or bitten, the leaf ending abruptly or jagged, as if bitten off at the apex ; as in palmetto, or dwarf palm.

74. Pulverated, the leaf being covered over with a farinaceous or mealy dust ; as the powdered auricula.

75. Punctated, full of punctures, or hollow points or dots ; as St. John's wort.

76. Quadrangular, the leaf having four prominent angles in the circumscription of its disk ; as corn horse-tail : quinquangular, or pentangular, when the leaf has five angles ; as in fig. 67.

77. Quinquelobated, when a leaf has five distinct lobes or divisions ; as the sycamore-tree.

78. Reniform, or kidney-shaped ; the leaf subrotund, hollowed at the base, without angles, resembling a kidney ; as in the European asarabacca.

79. Retuse, when the apex of the leaf is blunt, terminating in an obtuse sinus ; as yellow clusia.

80. Rhomboid, or diamond-shaped ; the two lateral angles being least, and the base broader than the apex ; as the smaller upright mallow.

81. Rugous, or wrinkled ; when the surface of the leaf

leaf is rough, or rises in blisters, from the contraction of the veins; as in common sage.

82. Runcinated, or notched, when the leaf is doubly and unequally serrated, the angles pointing contrary to the serratures; as in dandelion.

83. Sagittated, or arrow-shaped, the leaf triangular, hollowed at the base, and furnished with angles; as the common arrow-head.

84. Scabrous, or rough, beset with little tubercles on the disk; as the leaves of hops.—Serpentine, when the edge of the leaf is cut in the form of a serpentine line, without serratures, angles, or corners; as in fig. 26 and 34.

85. Serrated, notched, or jagged; acutely, when the margin is notched with imbricated angles, and whose shortest sides is next the apex; as dog's mercury.

86. Serrated obtusely, when the angles are obtuse; as in stinking horehound.

87. Serrated doubly, when the greater serratures are again cut into little notches or teeth; as in the bramble.

88. Sericeum, or silky, when the surface of the leaf is remarkably soft, and covered with silky hairs or down; as the silver-tree.

89. Setaceous, or bristle-shaped, when the leaf consists only of small bristly fibres; as asparagus.

90. Sinuated, or indented, when the lateral sinuses are considerably dilated; as the common oak.

91. Spatulated, or battledore-shaped, when the leaf is rounded at the apex, and lengthened downwards by a narrow linear base; as the Canary houseleek.

92. Striated, scored on the surface with channelled streaks or grooves, running lengthwise in parallel lines; as the round-rooted bastard cypress.

93. Spinous, or thorny, running out into hard or rigid spines, or stinging prickles; as prickly bear's-breech.

94. Subrotund,

94. Subrotund, when the leaf is nearly circular in its circumference; as *rhus cotinus*, the sumach or poison-tree.

95. Subulate, or awl-shaped, gradually tapering from the base to the apex; as *mesembryanthemum bicolor*.

96. Sulcated, or furrowed, when the leaf is longitudinally channelled; as in greater fox-glove.

97. Tomentose, or woolly, when the leaf is covered with a whitish down, whose hairs are interwoven and parallel; as the great white mullein.—Triangular, when the leaf has three prominent angles round the disk; as shown at fig. 20 and 27, which are the leaves of buckwheat and sea-purslain.

98. Triqueter, or three-sided, when the three sides are equal; as in the flowering rush.

99. Trilobous, or three-lobed, when divided to the middle into three distinct parts, with the margin convex; as the Carolina bay.

100. Truncated, or blunt-topped, the leaf having its apex as it were cut off; as in the tulip-tree.

101. Tubulous, or hollow, when cut transversely it is hollow within; as in common onion.

102. Villous, and viscous, when the surface of the leaf is covered with hairs, and is clammy or viscid; as the cotton, or stinking groundsel.—Umbilicated, when at the insertion of the peduncle, the leaf forms a cavity in the middle like a navel; as the peltated geranium, fig. 16; the water navel-wort, fig. 34; and the Indian crests, fig. 58.

103. Urens, or stinging, when furnished with fragile stimuli, that are burning or stinging; as the common nettle.

104. Undulated, or waving, when the disk of a leaf rises and falls convexly towards the margin; as the Cape aloë.

105. Ventricose, narrowing at the end, swelling out



Compound Leaves.

Engraved by the artist, from the original, by A. R. Wallace.

A. R. Wallace.



out in the middle, and hollow within; as the purple side-saddle flower.

Figures of the Compound Leaves.

PLATE VI. Fig. 1. Bigeminatè, or twin-forked, when a dichotomous or forked petiole has two folioles, i. e. compound leaves, on the apex of each division; as the sensitive plant, *mimosa unguis cati*.

2. Binate, in pairs, or one of the digitated leaves with two folioles only; as in *gypsophila fabago*.

3. Bipinnate abrupt, when the petiole has lateral pinnated wings, without a terminating foliole at the top; as the yellow nicker-tree.

4. Bipinnate with an odd foliole, when the wings terminate with a foliole at the top; as in the Canada nicker-tree.

5. Composite, when a simple petiole bears several leaves upon it; as the crowfoot or butter-cup.

6. Conjugate, and biternate, when two folioles are on each petiole, and no more; as the everlasting pea.

7. Decomposite, when a petiole once divided connects many folioles upon it; as rue.

8. Deformed, when folioles of different figures are upon the same petiole; as in piony of the shops.

9. Digitate, when more than one leaf is connected at the extremity of one petiole; as in the chaste-tree. — Geminatè, when two leaves grow out from the same point in pairs; as shown at fig. 2.

Jugum, or jugate, is a winged leaf with a single pair of folioles or leaflets. Bi-jugate, has two pair of folioles or leaflets. Trijugum, three pair; as in senna, *caffia-tora*, fig. 10. Quadrijugate, having four pair; as in the *caffia-foliata*, fig. 11. Quinquejugate, sexijugate; as *caffia-bisflora*; or twelve times jugate; as *caffia-javanica*, fig. 12.

13. Pedated, or bird-footed, when a bifid petiole connects folioles on its interior side only; as in common dragon.

14. Pinnated,

14. Pinnated, or winged; abruptly, when a simple petiole, on its lateral sides, bears many folioles or leaflets, without a terminating cirrhous or foliole; as in fenna.

15. Pinnated with an odd one, when a pinnated or winged leaf has a terminating foliole or leaflet; as in the service tree.

16. Pinnated alternately, when the leaflets or folioles come out on each side one after another; as in indigo.

17. Pinnated interruptedly, when larger folioles are intercepted with smaller leaflets between; as in agrimony.

18. Pinnated with a cirrhous, when a pinnated leaf terminates with a tendril; as the garden pea.

19. Pinnated articulately, when the petiole or stem of a pinnated leaf is articulated, and the leaflets spring from the articulations; as sagara tragodes.

20. Pinnated decursively, when the bases of the folioles are continued on the sides of the petiole or footstalk of a pinnated leaf running down the stem; as in the honey-flower.—Pinnated doubly, when the petiole of a pinnated leaf bears pinnated wings; as in fig. 3 and 4.

21. Pinnated triply, or triplicate, when the petiole of a bipinnated leaf supports bipinnated wings; as in fern.

22. Quinated, when a digitated leaf has five folioles; as the bramble or blackberry.

23. Supra-decomposited, when many leaflets are united on a many times divided petiole or footstalk; as the yellow fumitory.

24. Ternate, with the folioles petiolate, when a compound leaf has three petiolated folioles upon one petiole; as the African fumach.

25. Ternated sessile, when the leaflets grow immediately to the stem, without any petiole; as the pigeon pea.

26. Ternated

BOTANY.





Determinate Leaves.

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26. Ternated doubly, when three folioles are set on one petiole, and each petiole is ternate; as in barren-wort.

27. Ternated triply, when one petiole bears three folioles, and each of the folioles is ternate; as in the berry-bearing angelica with a naked stalk.

Figures of the Determinate Leaves.

PLATE VII. Fig. 1. Appressed, the disk of the leaves pressing or turning towards the stem; as in mithridate mustard.

2. Adverse, when the leaves turn towards the south, and not towards the sky; as ginger.

3. Alternate, when the leaves, instead of growing out in pairs, are set one above another, in opposite directions; as the African kiggelaria.

4. Amplexicaul, embracing the stem, when the base of the leaf entirely surrounds the stem transversely; as the white hellebore.

5. Approximate, when many leaves occupy the same branch, so as to leave scarcely any space between them; as the berry-bearing yew.

6. Axillary, when the leaves grow out of the angles formed by the branches and the stem; as parthenium or feverfew with entire leaves.

7. Bifarious, when the leaves diverge, or point from opposite sides; as the silver fir.—Bractæ, or floral leaves, are such as accompany the flowers; see fig. 17.—Cauline, leaves growing immediately on the stem, without any petiole or footstalk, as in fig. 6.

8. Coma, or bushy; when a bunch of leaves terminates the stalk, or flowering stem; as in the crown imperial.

9. Connate, when two opposite leaves grow together, or unite at the base, so as to have the appearance of one leaf; as in lacinated teazel.

10. Decurrent, or running down; when the base of a sessile leaf extends itself downwards along the stem,

stem, beyond the proper base or termination of the leaf; as in peach-leaved campanula.

11. Decussate, leaves divided in pairs, each pair growing alternately on opposite sides of the stem; as Oswego tea.

12. Demersed, in aquatic plants, leaves sunk below the surface of the water; as the water-violet.

13. Dependent, or hanging down; leaves whose apex points directly to the ground; as moving French honey-suckle.

14. Distich, leaves growing in two rows or lines, from the base to the apex; as the deciduous cypress.

15. Erect or upright, when the leaves form an acute angle with the stem; as corn-marigold with spear-shaped leaves.

16. Fasciculated, many leaves growing in a tuft from the same point; as in the larch-tree.

17. Floral; the bractæ, or leaves that are annexed to, or grow near upon, the flower; as in large-leaved theobroma, or chocolate-nut-tree. The leaves on the top of the crown imperial, fig. 8, are also bractæ, or floral.

18. Imbricated, growing together erect, and mutually covering each other like tiles; as in common cypress-tree.

19. Inflex, the leaves bending inwards towards the stem; as in calamiform fig-marigold.

20. Natant, swimming on the surface of the water; as broad-leaved pond-weed.

21. Oblique, when the apex of the leaf points obliquely towards the horizon; as the chequered tulip.

22. Patent, when the leaves form an acute angle with the stem; as rose-bay.

23. Perfoliated, when the base of the leaf entirely surrounds the stem; or when the stalk grows through the centre of the leaf; as the New-England hemp-agrimony.—Petiolated, growing on a footstalk at the margin or base; as in fig. 13 and 20.

24. Quaternate,

24. Quaternate, when verticillate leaves come by fours, having four in each whirl; as in Virginian clove lychnis.

25. Quinate, having five leaves growing from the same point; as in Weymouth pine.

26. Radicant, leaves bending to the ground, and taking root where they touch the earth; as *asplenium rhizophyllum*, spleenwort.—Ramous, when the leaves grow only on the branches, and not on the trunk; as shown at fig. 6 and 31.

27. Reclining, bending downwards; so that the apex of the leaf is lower than its base; as in strawberry-blite.

28. Resupinate, when the upper side of the leaf is turned downwards, facing the earth, and the lower or under disk is turned upwards, facing the sky; as *alstroemeria pelegonia*.

29. Revolute, when the leaf is rolled back, or curled under; as in sweet-william.

30. Seminal, or seed-leaves; those leaflets which arise immediately from the cotyledon, or lobes of the seed, after sowing, and appear first out of the ground; as raddish.—Semi-amplexicaul, leaves which embrace or surround the stem only half-way; as shown in fig. 2.—Sessile, when the leaves sit upon or grow immediately to the stem, without any petiole or footstalk; as in fig. 10.

31. Sparsed, when the leaves are numerously scattered on a plant, without any regular order; as in the myrtle-leaved polygala, or milk-wort.—Sesate, when leaves grow in sixes, or come out at one joint in a stellated form; as shown at fig. 34.

32. Trinate, when three leaves grow from the same point; as in the marsh American pine.

33. Vaginant, or sheathed, when the base of the leaf forms a sheath that infolds the stem; as Indian reed.—Vertical, when leaves grow erect, or in such

an upright position, that the apex of the one nearly touches the base of the succeeding; as in fig. 15.

34. Verticillate, leaves growing in whirls, or surrounding the stem like the rays of a wheel; as in dyer's madder.—There is another species of leaves, called *stipula*, or stipules; being a sort of props, or small scales of leaflets, generally situated at the base of the footstalks, for the purpose of supporting them on their first appearance. They are sufficiently evident in the stalk of dog's mercury, represented at fig. 35. marked *a*, *b*, *c*.

Of the FLOWER, or FRUCTIFICATION.

Though the flower be subject to such a number of varieties, yet the essential parts being constant, and provided likewise with male and female organs, somewhat analogous to those of the animal kingdom, Linnæus very judiciously fixed upon this part of the vegetable only, whereon to found the classification of his sexual system.—The term *fructification* was adopted on purpose to include the fruit or seed; for, though the fruit does not swell and ripen till after the flower is fallen, its rudiment, or first beginning, is nevertheless in the flower, of which therefore it properly constitutes a part. There is also another very curious fact, deserving our notice, which is, that every flower is perfectly formed interiorly, many months before it appears outwardly; or, in other words, the flowers which appear *this* year, are not, strictly speaking, the flowers of this year, but of the last. For instance, mezereon usually flowers in January; but these flowers are completely formed in the month of August preceding. Of this circumstance any one may be easily convinced, by only separating the coats of a tulip-root about the beginning of September; and he will find that the two innermost divisions form a kind of cell, in the centre of which stands the young flower, which is not destined to make its appearance
till

till the following April or May. Hence Linnæus defines the fructification to be, a temporary part of every plant, allotted to generation; whereby the Creator has established the means of preservation and increase to each individual of the vegetable tribe.

By the rules of Botany, a flower is divisible into the following parts: 1. The *Calyx*, cup, or empalement. 2. The *Corolla*, leaves, or petals, which form the blossom; including likewise a part called the *Nectary*, or honey-cup. 3. The *Stamina*, or male organ; called also filaments, threads, or chives. 4. The *Pistillum*, or female organ, by some termed the pointal. 5. The *Pericarpium*, or seed-vessel. 6. The *Semina*, seeds, or fruit. 7. The *Receptaculum*, receptacle, or base, on which the flower or fructification is seated.—These several parts we shall now separately describe.

The *CALYX* is formed of the termination of the cortex or outer bark of the plant; which, after accompanying the trunk or stem through all its branches, at last breaks out with the flower in this new form. Its chief use is to enclose and protect the other parts. It is distinguished by different appellations, according to the circumstances with which it is attended, viz. *Perianthium*, or flower-cup, when it is placed close to the fructification. *Involucrum*, proper, when stationed at the foot of an umbel, and at a distance below the flower; it is an universal involucrum, if placed under an universal umbel; or a partial one, if under a partial. *Amentum*, or catkin, when the calyx proceeds from one common receptacle, resembling the chaff of an ear of corn. *Spatha*, or sheath, when it bursts open lengthways, and puts forth a spadix. *Gluma*, or husk, when proper to grasses, which it folds over with its valves; and the sharp point or beard issuing from the glume is called *Arista*. In mosses, the calyx is termed *Calyptra*, and is placed like a veil over the antheræ or stamens. In the

the fungi or mushroom tribe, it is called *Volva*, or curtain, from its extended form.

It may in some cases appear difficult to distinguish a calyx from the bractæ or floral leaf, such as is found to accompany the fructification of the lime-tree, lavender, cow-wheat, and some others. They may however be distinguished by this certain rule, that a calyx always withers when the fruit is ripe, if not before; but the floral leaf will remain longer. Without attending to this, mistakes might easily be made in hellebore, fennel-flower, passion-flower, wild Syrian rue, and others, in which the calyx is wanting. In many flowers the calyx is deciduous, dropping off as soon as the flower begins to expand; this is the case with barren-wort, and poppy.

We are next to consider the different structure of the calyx, which admits of many variations and definitions exclusive of the above. These chiefly depend on the fabric, and variety of the forms, which are to be distinguished with regard to number, composition, parts, and segments. In respect to *Number*, the calyx is either *single*, as in the primrose, and most flowers; *double*, as in common mallow, Syrian mallow, and anotta; or *wanting*, as in the crown imperial, tulip, and many of the liliaceous flowers. In respect to *Composition*, it is either *imbricate*, that is, composed of many scales lying over each other, as in hawk-weed, sow-thistle, and oriental centaury; *squarrose*, or composed of scales divaricated on all sides, and spreading widely open, as in common thistle, cotton thistle, and the greater fleabane; *acutius*, augmented, having a series of distinct leaves, shorter than its own, that surround its base externally, as in the tickseed sunflower, water hemp agrimony, the pink, and carnation; or *multiflorous*, common to many florets, as in scabious, and the compound flowers. In respect to its *Parts*, the calyx is either *monophyllous*, of one leaf, as in thorn-apple and alder-leaved *Hermannia*;
diphyllous,

diphyllous, of two, as in fumitory and fumaria bulbosa; *triphyllous*, of three, as in Virginian spider-wort; *tetraphyllous*, of four, as in barren-wort and pearl-wort; *pentaphyllous*, of five, as in the rock-rose, pheasant's eye, and cerbera; *hexaphyllous*, of six, as in the barberry or pimperidge bulb; and *decaphyllous*, of ten, as in the Syrian mallow and the prickly teazel. In respect to its *Segments* (which chiefly concern the monophyllous calyx), it is either *integer*, or whole, as in genipa; *bifid*, or divided into two segments, as in hooded milfoil; *trifid*, in three, as in water plantain and Cliffortia; *quadrifid*, in four, as in elephant's head; *quinquefid*, in five, as in the bramble; *sexfid*, in six, as in pavetta; *octofid*, in eight, as in tormentil; *decemfid*, in ten, as cinquefoil and strawberry; or *duodecemfid*, in twelve, as in willow-herb.

The calyx also varies with regard to its *figure*, which includes the terms of its equality, margin, and apex. In respect to its *Figure*, it is either *globous*, or globe-shaped, as in the berry-bearing chickweed, and burning thorny-plant, or spurge; *clavate*, or club-shaped, as in viscous campion; *reflex*, bent back, as in the globe-thistle; or *erect*, upright, as in tobacco and primrose. In respect to *Equality*, it is either *equal*, as in campion; or *unequal*, as in helianthus; or with the segments *alternately shorter*, as in cinquefoil and tormentil. In respect to its *Margin*, it is either *integerrimous*, very entire, as in most plants; *ferrate*, or sawed, as in some species of St. John's wort; or *ciliate*, fringed, with hairs like an eye-lash, as in some species of blue-bottle, and knapweed. In respect to its *Apex*, or top, it is either *acute*, or sharp, as in androsace, and great curled dock; *acuminate*, or pointed, as in henbane; *obtuse*, or blunt, as in water-lily and Garcinia; or with one of its indents lopped off, as in vervain.

The calyx likewise differs in its proportion, situation, and duration. With respect to *Proportion*, it is
either

either *longer* than the corolla, as in rose-campion, pearlwort, and some species of antirrhinum; *equal* to it, as in some species of cerastium; or *shorter*, as in viscous campion. In respect to *Situation*, it is either a calyx of the *flower*, as in Linnæa; or of the *fruit*, as in Morina; or of the *fructification*, as in peony. In respect to *Duration*, it is either *caducous*, falling off at the first opening of the flower, as in poppy and barren wort; *deciduous*, with the corolla, as in barberry; or *persisting*, till the fruit is come to maturity, as in snap-dragon and rattle-coxcomb.

The preceding variations of the calyx chiefly appertain to the perianthium. Those which relate to an *Involucrum* are as follow: An involucrum is either *monophyllous*, as in hare's ear; *diphyllous*, as in euphorbia or spurge; *triphyllous*, as in flowering-rush, and water-plantain; *tetraphyllous*, as in dog-wood, and cornelian-cherry; *pentaphyllous*, as in carrot; or *hexaphyllous*, as in the blood-flower. The *Spatha* also varies, being either *monophyllous*, as in daffodil; *diphyllous*, as in water-soldier; or *imbricate*, as in the plantain-tree.

In the engravings which are selected to exemplify the sexual classification, all these parts of the flower are figured in a great number of different instances; we shall nevertheless give a few examples, in the annexed Botanical Plate VIII. in order that the learner may more readily comprehend the subject as we go on, and become master of it before we treat of the *Genera* and *Varieties* of plants. In this plate, fig. 1. represents a quinquefid calyx, or perianthium of the fructification; it is that of the bramble, which supports both the stamina and the germen. 2. A monophyllous perianthium or cup; the alder-leaved Hermannia. 3. A decaphyllous perianthium; the prickly teazel. 4. A globe-shaped calyx, with its segments above the germen; the burning thorny plant or spurge. 5. An imbricated perianthium; the oriental centaury.

BOTANY.

Plate VIII.



taury: 6. A triphyllous involucrum, proper; the blue passion-flower. 7. An amentum, or catkin; the hazel nut-tree. 8. A spatha, or sheath; the arum maculatum, or wake-robin. 9. A gluma, or husk; the wild oat. 10. A calyptra, or veil, covering the anthera in mosses; the matted bryum. 11. The volva, or curtain, proper to the fungi.

The COROLLA, or blossom, is that beautifully-coloured part of a flower, which attracts the attention of every beholder. It is composed of one or more petals, or blossom-leaves; and is said, by Linnæus, to be an expansion of the inner bark of the plant. Its use is similar and secondary to that of the calyx, serving as a defence to the delicate organs of sex, to the nectary, and germen, which in general lie within the corolla, and seem to be the parts pregnant with perfume, as well as destined for the propagation of vegetable life. The leaves of which the corolla consists are called *petals*, and are thus distinguished from the green leaves of the plant, with which they might else be confounded. The ancients, indeed, seem to have had no distinct term whereby to express this part of the fructification; and hence Virgil, in describing the amellus, a species of aster, the flower of which has a yellow middle and purple rays, calls it a golden flower surrounded with purple leaves:

*Aureus ipse (flos), sed in foliis, quæ plurima circum
Funduntur, violæ subluce purpura nigræ.* Geor. iv.

This loose expression, which is chargeable rather on the language than the poet, has misled all his translators: May and Addison, Dryden and Dr. Trapp, have all applied the colours of the flower to the *leaves* or *boughs* of the plant. Dr. Trapp has even applied the golden colour to the *stem*, and the purple to the *leaves*:

For from one turf a mighty grove it bears;
 Its *stem* of golden hue, but in its *leaves*,
 Which copious round it sprout, the *purple* teint
 Of deep-dyed violets more glossy shines.

The structure of the corolla, like that of the calyx, is subject to a great number of variations. If the corolla be *monopetalous*, or of one petal, it consists of two parts, viz. the *Tube*, or lower part, which is usually tube-shaped; and the *Limb*, or upper part, which expands or spreads wider. The limb also, according to its figure, is either *campanulate*, bell-shaped; that is, bellying out, and without a tube; *infundibuliform*, or funnel-shaped; of the figure of a cone, and standing on a tube; *hypocrateriform*, or salver-shaped; plain or flat, and standing on a tube; *rotatory*, or wheel-shaped, flat, without a tube; or *ringent*, gaping; that is, irregular, and personated with two lips. If the corolla be *polypetalous*, or of many petals, each petal consists of an *unguis*, or claw, which is the lower part fastened to the base; and a *lamina*, or thin plate; which is the upper part, usually expanded or spreading. A polypetalous corolla is *cruciform*, or cross-shaped, when it consists of four petals that are equal and spreading; and *papilionaceous*, or butterfly-shaped, when it is irregular, consisting of four petals, of which the under one resembles the keel of a ship, the upper one rises, and the two side ones stand single.

The variations of the corolla, in respect to *Number*, concern either the petals or segments. It is *monopetalous*, or of one petal, in bind-weed and primrose; *dipetalous*, of two, in day-flower and enchanter's-nightshade; *tripetalous*, of three, in arrow-head and water-plantain; *tetrapetalous*, of four, in the stock July-flower; *pentapetalous*, of five, in the white bean-tree; *hexapetalous*, of six, in the tulip, duck's foot, and white narcissus; *enneapetalous*, of nine, in the tea-tree

tea-tree and tulip-tree; and *polypetalous*, of many, in water-lily, and spring adonis. With regard to the segments, which concern rather the monopetalous than the polypetalous flowers, being but rarely observed in the latter, the corolla has either *two*, as in chickweed, and enchanter's nightshade; *three*, as in Holotheum and Hypecoum; *four*, as in campion; or *five*, as in mignonette.

The variations of the corolla in regard to *figure*, include also its equality and margin. In this respect, it is *undulate*, or waved, in the superb lily; *plicate*, or folded, in the convolvulus; *revolute*, or rolled back, in asparagus, and medeola; and *tort*, twisted, in rose-bay, swallow-wort, and periwinkle. In respect to *Equality*, it is *equal*, in the primrose; *unequal*, in the flowering-rush; *regular*, in columbine; and *irregular*, in wolf's bane, and dead nettle. Its *Margin* is either *crenate*, or notched, as in flax; *serrate*, or sawed, as in the lime-tree, and water-plantain; *ciliate*, or fringed, as in rue, bog-bean, and Indian-cress; *denticulate*, or jagged, as in water-pimpernel, and iron-wood; or with a *hairy* surface, as in bog-bean, and some species of hypericum.

As to *Proportion* in the corolla, it may be very long, as in the lily-thorn, Brunsfelsia, and Siphonanthus; or very short, as in pearl-wort, base-pimpernel, currant, and gooseberry. In respect to *Situation*, the base of the corolla is generally close to the perianthium, if there be one; it is indeed separated from it by the germen, in moschatel, greater wild burnet, and marvel of Peru, but these instances are very rare. With respect to *Duration*, the corolla is either *persistent*, lasting till the fruit is ripe, as in water-lily; *caducous*, dropping as soon as the flower is blown, as in herb Christopher, and meadow-rue; *deciduous*, dropping off with the flower, which is most common; or *marcescent*, withering, but not falling, as in the bell-flower, butterfly-flower, cucumber, gourd, and bryony.

Between the calyx and corolla nature has put no absolute limits; as is plain from mezereon, in which plant they grow together, and are united in the margin, like a leaf of the box-tree; but they may be commonly distinguished by their position in respect of the stamina, the petal and stamina being ranged alternately; whereas the segments of the calyx and the stamina answer to each other. That this is their natural situation, appears from the complete flowers in the classes tetrandria and pentandria: and the use of applying this rule will be found in the instances of wild orache, pellitory, and nettle; where it decides, that the single cover in those genera is a perianthium, and that it is the corolla that is wanting. Should we infer, where only one of the two covers appears, that it is a corolla, because that is a more principal part, there would be no certainty from such an inference; as is evident from the ammania, isnardia, ruellia, water-purflage, and bell-flower, in all which the corolla is often found wanting, but not the calyx.

That the calyx, as proceeding from the cortex of the plant, is coarser and thicker than the corolla, which is produced by the soft, pliant, inner bark, is obvious to every one. But there are no limits determinable from any such circumstances, unless it be from the colour; and even this is not sufficient; for the perianthium of the Bartsia is blood-coloured; and there are also many flowers whose corollæ are coloured, naked, and subject to lose their petals when in the state of flowering, but which afterwards harden and turn green, and remain on the plant like a calyx; as for instance, the hellebore, and star of Bethlehem. The euphorbia has deceived many, who have described it as monopetalous, taking the calyx for the corolla; but that the *petalæ*, as they are called, upon the leaves of the lichen, are really the petals of the flower, is proved by some annual species in India, in which there are white petals very distinguishable.

Delineations

Delineations of different corollæ are given in Plate VIII. where fig. 12. shows a monopetalous tube-shaped corolla; *a*, the tube, *b*, the limb; it is the blossom of a cowslip. 13. A bell-shaped corolla; *campanula trachelium*, or Canterbury-bell. 14. An infundibuliform or funnel-shaped corolla; the common comfrey. 15. An hypocrateriform or salver-shaped corolla; the narrow-leaved kalmia. 16. A rotatory or wheel-shaped corolla; the winter-cherry. 17. A ringent or lipped corolla; the foxglove. 18. A cruciform or cross-shaped corolla; the stock July-flower. 19. A papilionaceous or butterfly-shaped corolla; the everlasting pea. 20. An hexapetalous corolla; the white narcissus. 21. A polypetalous or many-petalled corolla: the spring adonis.

NECTARIES are those parts of a flower which are destined to contain or prepare the melliferous juices of the plant; and, though they seem essential to the fructification, yet have they passed undistinguished by all the older botanists, who confounded them with the petals of the flower. Linnæus first defined the nectarium to be, that part of the fructification which bears the honey belonging to the flower. In its form and manner of appearance, it affords a wonderful and curious variety. In the honeysuckle, the tube of the blossom serves the purpose of a nectary; but in other flowers there is a peculiar organization contrived for this purpose. In the daffodil and columbine, these parts are very large; for in the former the cup, and in the latter the horns, are nectaries; but in other flowers they are so remarkably small, as scarcely to be discoverable under the microscope. In some plants it is united with, and makes part of, the petals; in others it is detached from them. Its shape and situation are also as various; nor is its use absolutely known, unless the supposition of its secreting the honey can be depended upon. In its form and character it admits of the following distinctions, viz.

Calcariate

Calcariate nectaria, such as resemble a calcar or spur; and these are either in monopetalous flowers, as in valerian, rose-bay, hooded milfoil, and butterwort; or in polypetalous, as in butterfly-flower, larkspur, violet, and fumitory. *Nectaria* that lie within the *substance* of the petals; these are found in crown-imperial, lily, flower-de-luce, Hermannia, ranunculus, pine-apple, barberry, and dog's-tooth violet. *Nectaria* that *crown* the *corolla*; as in passion-flower, daffodil, viscous campion, African swallow-wort, balsam-tree, witch-hazel, and African spiræa. *Nectaria* of *singular* construction; as in mignonette, heart-pea, ginger, turmeric, nettle, base or pine, vanellœ, screw-tree, and willow. *Calycine nectaria*, such as are seated upon the calyx; as in Indian cress, bird's-nest, buckler-mustard, and Malpighia. *Stamineous nectaria*, such as attend the stamina; and these are either upon the antheræ, as in base flower-fence; or upon the filaments, as in bay-tree, fraxinella, bean-caper, day-flower, marvel of Peru, lead-wort, bell-flower, and Roella. *Pistillaceous nectaria*, such as accompany the pistillum; these are upon the germen, as in hyacinth, flowering rush, dame's violet, rocket, &c. *Receptaculaceous nectaria*, such as to join the receptacle; as in lathræa, Collinsonia, lesser house-leek, navel-wort, mercury, sea-side laurel, honey-flower, and African spiræa.

These are the forms in which the nectary most usually presents itself in different corollæ; it must however be acknowledged, that the term seems in some cases to be applied to such parts as do not appear to secrete, or even to contain, any honey-like liquor; but until the uses of these parts shall be better ascertained, and the economy of vegetable life be more fully understood, an attempt to limit the use of the terms, and to create new ones, would be premature. Figures of different nectaries are given in the above-mentioned Plate, where fig. 22. is the nectary

or

or honey-cup of the daffodil. 23. The horn-shaped nectary of the columbine. 24. A nectary lying within the substance of the petal of the ranunculus. 25. Nectaries in the form of little globes supported on pillars, as in grass of Parnassus. 26. A calcariate nectary, of the rose-bay. 27. A nectary that crowns the corolla; it is that of the passion-flower.

The STAMINA, or chives, are those upright filaments, which, on opening a flower, we find within the corolla, surrounding the pistils. According to Linnæus, they are formed of the woody substance of the plant, and are the male organs of generation. Each stamen consists of two parts; viz. the *filament*, or thread, which serves to elevate the anthera, and connect it with the flower; and the *anthera*, or summit, which is the essential part; its office being to secrete or prepare the pollen for the impregnation of the germen. The characters which distinguish these parts are the following:

The *Figure* of the filaments is either *capillary*, like hairs, as in plantain; *plane*, or flat, as in star of Bethlehem; *cuneiform*, wedge-shaped, as in meadow-rue; *spiral*, screw-shaped, as in hirtella; *emarginate*, nicked or notched, as in porana; *reflex*, bent back, as in the superb lily; or *hirsute*, hairy, as in the Virginian spider wort, and anthericum. The *Proportion* of the filaments is either *unequal*, as in spurge-laurel, campion, and saxifrage; *irregular*, as in the honey-suckle; *very long*, as in trichostema, plantain, and hirtella; or *very short*, as in great curled dock. The *Situation* of the filaments is either *opposite* to the leaves or segments of the calyx, as in the nettle; or *alternate* with them, as in oleaster, or wild olive. In monopetalous flowers they are inserted into the corolla, but scarcely ever in polypetalous. They are inserted in the calyx, in willow-herb, tree-primrose, Ludwigia, water-purslane, sea-milkwort, and soap-wood; and in some flowers that have no petals, as in wild olive;
but

but it is most common for them to be inserted into the receptacle, like the calyx and corolla.

With respect to the variation of the *Antheræ*, there is either a single one to each filament, as in the generality of plants; one common to three, as in the gourd; one to five, as in the cardinal-flower, sun-flower, and dandelion; two to each filament, as in mercury; three to each, as in fumitory; five to three filaments, as in briony; or five to each, as in the chocolate-nut-tree. In some plants that have single antheræ common to the filaments, we not unfrequently find some of the anthers wanting; thus, one is wanting in Cleonia, and Martynia; two in butter-wort, and vervain; three in hedge-hyssop, and in some trumpet-flowers and geraniums; four in turmeric; and five in pentapetes, and some geraniums. The number of cells that contain the pollen, is either one, as in mercury; two, as in hellebore; three, as in the butterfly-flower; or four, as in crown imperial. The *Figure* of the antheræ is either oblong and incumbent, as in lilies; globous, as in mercury; sagittate, or arrow shaped, as in crotus; subulate, or awl-shaped, as in the tulip; or cornute, horned, as in witch-hazel, winter-green, whortleberry, and heath. They burst either on the side, as in the greater snow-drop, and most flowers; on the apex, as in balm-leaved melissophyllus, and Kiggelaria; or from the apex to the base through the whole length, as in barren-wort and lion's-leaf. They are fastened either by their base, as in most plants; by their tops, as in meadow saffron; or by their sides, adhering to the nectary, as in Indian reed. Their *Situation* is either on the tops of the filaments, as in most plants; on the sides of the filaments, as in true-love and asarabacca; on the pistillum, as in birthwort; or on the receptacle, as in wake-robin.

The figure of the *Particles of Pollen* appears under the microscope to be either globus echinatus, a prickly ball, as in the sun-flower: perforate, as in geranium

or

or crane's-bill; *double*, as in comfrey; *rotato-dentate*, or wheel-shaped and indented, as in mallow; *angulate*, or cornered, as in violet; *reniform*, or kidney-shaped, as in daffodil; or *convolute*, like a leaf rolled up, as in borage.

Representations of the stamina are given in Plate VIII. where fig. 28. shows the filament with an awl-shaped anthera; it is that of the tulip. 29. A stamina of the crocus, showing the filament with an arrow-shaped anther. 30. A reflex filament with an oblong anthera; it is that of the lily. 31. Stamina with unequal filaments, and globous anthers; the African geranium. 32. A stamina with a plane filament, and horned anthera; the fir-beath. 33. A stamina with five filaments, and one anthera; the cardinal flower. 34. A stamina with its anther two-celled, globous, and double; the willow. 35. A stamina with its anther bursting at the apex, and shedding the pollen; it is the balm-leaved melisphyllus. 36. A stamina with its anther adhering to the margin of the superior side of a nectary; it is the Indian reed. Several of the figures are magnified, to make them conspicuous and intelligible to the reader.

The PISTILLUM, or pointal, is a little upright column, generally placed in the centre of the flower. It is formed of the medulla or pith of the plant, and is the female organ of generation, whose office is to receive the pollen or farina of the male, and produce the fruit. It is composed of three parts: 1. The *germen*, or seed-bud, which is the basis of the pistillum, and the rudiment or embryo of the seed, being the pericarpium in its early state. 2. The *stilus*, or shaft, which grows out of the germen, and elevates and supports the stigma or summit. 3. The *stigma*, which is the apex or summit of the pistillum, charged with a viscous liquor that receives the pollen, and is compared by Linnæus to the *vulva* in female animals. By the action of the antheræ, which casts its pollen

upon this part, the female vegetable is impregnated. This curious operation is performed in the following manner: The antheræ, which at the first blowing of the flower are whole, burst, after a certain time, and discharge the pollen with an elastic force or spring, thus dispersing its mealy particles all over the interior of the corolla. Part of course lodges on the surface of the stigma, to which it is attracted and held by the moisture with which that part always abounds; and each single grain or atom of the pollen, bursting and dissolving in this liquor, as it has been observed to do under the microscope, is supposed to contribute some vivifying particle of spirit that impregnates the germen below. What the substance is that is so discharged, and whether it actually passes through the style into the germen, seems yet undetermined, it being difficult to ascertain and detect the subtle qualities of such minute parts. But whatever be the means by which nature produces the effect in question, the cause, as far as it has been here explained, seems indisputable and certain; and accordingly we see, that after this impregnation, when the parts of the flower that have done their office are fallen away, the germen swells to a fruit abounding with seeds, by which the species is propagated.

With respect to the variations in the structure of the pistillum, they are as follow: The *Lacinia* of the style or shaft are either *bipartite*, as in cornutia, and fresh-water aloe; *tripartite*, as in clethra, and sea-heath; *quadripartite*, as in buckthorn; *dichotomous*, halved; and each segment halved again, as in Sebesten plum. The *Figure* of the style is either *cylindrical*, as in holyhock; *angulate*, lanceolate, or sword-shaped, and sometimes with a peduncle, as in Indian reed; *subulate*, or awl-shaped, as in crane's-bill; *fili-form*, or thread-shaped, as in crocus; *club-shaped*, or thicker towards the apex, as in the greater snow-drop. In respect to length, it is either *very long*, as
in

in tamarind, wild fenna, bell-flower, Indian wheat, and viper's grass; *very short*, as in palmated rhubarb, and poppy; or of the length of the stamina, as in tobacco, and most flowers. In respect to bulk, it is either *thicker* than the stamina, as in the greater snow-drop; *thinner*, as in ceratocarpus; or of *equal* thickness, as in dead nettle. Its *situation* is either on the *apex* of the germen, as in most flowers; both *above* and *below* the germen, as in caper, and spurge, (unless the lower part in them be considered as the extension of the receptacle;) or on the *side* of the germen, as in the rose and raspberry, and also in hirtella and suriana.—The particular form and structure of the germen we shall not notice here, as it comes more properly under *Pericarpium*.

With respect to the variations of the *Stigma*, the number is either a single *one*, as in most flowers; *two*, as in lilac: *three*, as in palmated rhubarb; *four*, as in willow-herb, and grass of Parnassus; or *five*, as in winter-green. The *Segments* of the stigma are either *convolute*, rolled round, as in crocus; *capillary*, as in dock; *revolute*, or reflex, as in pink, carnation, and African crane's bill; or *bent to the left*, as in viscous campion. In respect to *Number*, the stigma may be bifid, trifid, quadrid, quinquid, or sexfid, divided into six parts, as asarabacca; or *multifid*, with many setaceous or hair-like divisions, as in nettle-leaved cistus, and holyhock. The *Figure* of the stigma is either *linear*, or pointed, as in Indian flowering-reed; *capitate*, or headed, as in caltrops, periwinkle, pomegranate, and the balsam-tree; *globous*, as in primrose, mud-wort, and water-violet; *ovate*, or egg-shaped, as in genipa; *obtuse*, or blunt, as in base heath; *truncate*, lopped, as in Indian arrow-root; *pressed down obliquely*, as in herb Christopher, and spurge laurel; *emarginate*, notched, as in melic, or rope-grass; *orbiculate*, rounded, as in willow-herb; *peltate*, or shield-shaped, as in the side-saddle

flower, water-lily, and poppy; *coroniform*, crown-shaped, as in winter-green; *cruciform*, cross-shaped, as in pennæa; *uncinate*, hooked, as in violet, and American viburnum; *canaliculate*, grooved or channelled, as in meadow-saffron: *concave*, hollow, as in violet; *angulate*, cornered, as in Muntingia; *striate*, streaked, as in poppy; *plumous*, feathery, as in palmated rhubarb, tamarisk, and the grasses; or *pubescent*, downy, as in berry-bearing chickweed, and chickling vetch. In respect to *Length*, it may be *capillary*, hair-like, as in Turkey wheat; or as long as the style, as in genipa. In respect to *Substance*, it may be *foliaceous*, resembling a thin leaf, as in flower-de-luce. In respect to *Duration*, it is *marescent*, withering, as in most plants; or *persisting*, as in the side-saddle flower, water-lily, and poppy. Some of these forms of the pistillum are represented in Plate VIII. Fig. 37. Pistillum of the African crane's bill: *a*, the germen; *b*, the style, subulate or awl-shaped; *c*, the stigma, quinquefid, revolute, or reflexed. 38. Pistillum of the Indian flowering-reed: *a*, the germen; *b*, the style, with a peduncle or footstalk, lanceolate; *c*, the stigma, linear or pointed, growing to the margin of the style. 39. Pistillum of the palmated rhubarb: *a*, the germen; *b*, the styles, three, very short; *c*, the stigmas, reflex, plumose. 40. Pistillum of the holyhock; *a*, the germen; *b*, the style, cylindrical, erect; *c*, the stigmas, multifid, setaceous. 41. Pistillum of the crocus; *a*, the germen; *b*, the style, filiform, or thread-shaped; *c*, the stigmas, three, convolute, serrated. 42. Pistillum of the pomegranate; *a*, the germen; *b*, the style, simple; tubular; *c*, the stigma, capitate, or headed.

The PERICARPIUM, or seed-vessel, is no other than the germen above described, grown to maturity. It is defined by Linnæus as an entrail of the plant big with seeds, which it discharges when ripe. Some flowers have no seed-vessels; in which case the seeds
are

are said to be *naked*; the cup, however, generally nourishes the seeds until they come to maturity. In the tribe of grasses, this office is frequently performed by what was before called the bloom or blossom.

The pericarpium is distinguished, according to the circumstances which attend it, by the following appellations: *Capsula*, or capsule, a chest or little casket, forming a pericarpium which envelopes the seed, but opens of its own accord in a determinate time. The inclosure which surrounds and covers the seeds externally is called a *valvule*, or valve; the partitions which divide it into compartments or cells, *dissepiments*; the substance which passes through the capsule, and connects the several partitions and seeds, *columella*; and the cells, or hollow compartments, in which the seeds are lodged, *loculaments*.

Siliqua, a pod, is a pericarpium with two valves, wherein the seeds are fastened along both the sutures or hinges of the valves. *Legumen*, another pod with two valves, but wherein the seeds are fastened along one suture only. *Conceptaculum*, or conceptacle, is a pericarpium of a single valve, which opens on one side lengthways, and has not the seeds fastened at all. *Drupa*, a pulpy or fleshy pericarpium, without any valve, containing a stone, as the plum, peach, &c. *Pomum*, a close pulpy pericarpium, covered by a continued thin membrane, and without valves, but containing a capsula; as the apple, pear, &c. *Bacca*, a berry, a full pulpy pericarpium, without valves, in which the seeds are naked, having no other covering; as the gooseberry. *Strobilus*, or cone, a pericarpium formed from an amentum; as the cone of the pine or fir-tree.

The variation of the pericarpium, in respect to external divisions, is either *unicapsular*, consisting of one capsule, as in campion; *bicapsular*, of two, as in peony, and swallow-wort; *tricapsular*, of three, as in white hellebore, and larkspur; *quadricapsular*, of four,

four, as in rose-root; *quinquecapsular*, or five, as in columbine; or *multicapsular*, of many, as in marsh-marigold, globe-ranunculus, and black hellebore. The fruit, in respect to the locuments, or *internal divisions* of the pericarpium, is either *unilocular*, of one cell, as in chickweed, and primrose; *bilocular*, of two, as in henbane, mustard, and cardinal-flower; *trilocular*, of three, as in the lily, and spurge; *quadrilocular*, of four, as in the tree-primrose, and spindle-tree; *quinquelocular*, of five, as in winter-green, and the yellow side-saddle flower; *sexlocular*, of six, as in asarabacca, and birthwort; *octolocular*, of eight, as in rhodiola, or rose-root; *decemlocular*, of ten, as in flax; or *multilocular*, of many, as in water-lily.

The pericarpium, in respect to the number of its valves or *outer inclosures*, is either *bivalve*, of two, as in celandine, and cabbage; *trivalve*, of three, as in violet, and Greek valerian; *quadrivalve*, of four, as in bale Virginian loosestrife, and primrose-tree: or *quinquevalve*, or five, as in water-violet. The dissepi-ments are either *parallel* to the valves, as in moonwort, and whitlow-grass; or placed the *contrary way*, as in buckler-mustard, and treacle-mustard. The pericarpium also varies in being *turbinate*, narrowing like a cone, as in the pyrus, or pear; *inflate*, puffed, as in heart-pea, and common bladder-lenna: *membranaceous*, composed of thin membranes, as in the elm-tree; *triquetrous*, *tetragonous*, *pentagonous*, of three, four, or five, sides, as in Averrhœa, bean-caper, &c. or *articulate*, jointed, as in bird's-foot, French honey-suckle, and hypecoum.

The opening of the pericarpium for discharging the seeds when the fruit is ripe, is either at the apex, which may be *quadridentate*, split into four segments, as in the pink and carnation; *quinquedentate*, into five, as in alfine, and garden balsam; or *decemdentate*, into ten, as in mouse-ear chickweed; opening at the base, *trifarum*, into three parts, as in arrow-headed grass,
and

and bell-flower; or *quinquesarium*, into five parts, as in marsh-cistus; at the angles or corners, longitudinally, or lengthways, as in wood-sorrel, and butterfly-flower; through a pore or hole, as in bell-flower; or horizontally, across the middle, as in pimpnel, plantain, amaranth, and purslane. All fruit that is in articulated or jointed pods, opens at every one of the joints, each of which is monospermous, or single-seeded. The ejection of the seeds is sometimes elastic, the pod bursting with a spring, as in spring-gourd, balsam-apple, lady's smock, sea-side laurel, spurge, palma Christi, and garden-balsam.

The pericarpium is generally shut; but in mignonette, and base hemp, it is always open. In the grass of Parnassus it gapes at the time of flowering, and closes afterwards. That the pericarpia are ever found one within another, the greater containing the smaller ones, Linnæus refuses to admit; for, although there is the appearance of such a singularity in the laurel-leaved tulip-tree, uvaria, and Michaelia, he thinks the outer pericarpium is in such cases to be looked upon only as a common receptacle. In the preceding Plate VIII. fig. 43. represents a capsule and section of the same, ovate, bilocular, divided at the apex, and surrounded with the calyx; the lobelia, or cardinal flower. 44. A capsule, and section of the same, scabrous on the outside, quinquelocular, quinquevalvular; the pistillum retained to show the shield-shaped stigma; *a*, the style, cylindrical; *b*, the stigma, quinquangular, reflex; the yellow side-saddle flower. 45. A capsule unilocular, quinquevalvular, bursting with an elastic force to discharge the seeds, the apices of the valves afterwards rolling up into a spiral; the garden-balsam. Examples of the other kinds of pericarpia will be figured in the ensuing Botanical Plates.

The SEED, or fruit, according to the definition of Linnæus, is a deciduous part of the vegetable, and the

the rudiment of a new one, quickened for vegetation by the irrigation of the parent plant. Its distinctions are as follow: A *Seed*, properly so called, is a close fleshy substance, enveloped with a firm skin, coat, or tunic. Its principal constituent parts are, 1. *Corculum*, the essence or primordium of the new plant, attached to, or involved in, the cotyledon or seed-lobes, in the form of a pin's head, or little heart. 2. *Plumula*, the ascending or feathery part of the corculum, from whence the seed-leaves proceed. 3. *Rostellum*, the descending part of the corculum, that forms the root. 4. *Cotyledon*, the lobes or sides of the seed, which perish as the corculum advances, and draws from them their radical moisture. 5. *Hilum*, the eye of a bean, or the external mark of the seed, where it had been fastened to the fruit or receptacle when it grew. 6. *Arillus*, the exterior coat of the seed, which falls off spontaneously at the proper season. 7. *Coronula*, the little coronet of a seed; which is either *calyculus*, the calyx of a floret adhering to the seed, and assisting it to fly off; or *pappus*, a down, which is a feathery, chaffy, or hairy, crown, answering the same end, and connected to the seed by *stipes*, a trunk, which is the thread or bristle whereby the down is raised and supported. 8. *Ala*, a wing, or membrane, also affixed to the seed, whereby it is carried away and self-sown.—*Nux*, a nut; which is a seed inclosed in an osseous epidermis, a bony or hard outer skin, commonly called the shell.

With respect to the *Number* of seeds, plants are either *monospermous*, having one seed, as in knot-grass, and Collinsonia; *dispermous*, two, as in carrot; *trispermous*, three, as in spurge; or *tetraspermous*, four, as in Tournefortia. In respect to the loculations of the seed itself, it has but one in most plants; but is *bilocular*, with two cells, in cornelian cherry, smaller burdock, valerian, and Sebesten plum. In respect to *Figure*, it is either *cinct*, girt, as in sandwort,

wort, and bryony; *cordiform*, heart-shaped, as in climbing African asparagus; *reniform*, kidney-shaped, as in the calhewnut-tree, and kidney-bean; *ovate*, or egg-shaped, as in milk-wort, and quill-wort; or *echinate*, prickly, as in *myosotis lappula*, and carrot. In respect to *Substance*, they are termed *osseous*, bony, as hazel-nut tree, gromwell, and nuts of every kind; or *callous*, tough, as in lemon, orange, shaddock, &c. The seeds have a *calyculus*, in scabious, base hemp-agrimony, and arctotis; a *pappus*, or down, in sow-thistle, base hawkweed, and goat's beard; an *arillus*, in coffee, jessamine, hound's tongue, cucumber, white dittany, and the staff-tree. In respect to *Situation*, seeds are either *nidulantia*, nestling, that is, dispersed about the pulp, as in water-lily; fastened to the *future*, as in plants that are siliquose or podded; fastened to the *columella*, as in mallow; or placed on *receptacles*, as in tobacco, and thorn-apple. In the foregoing Plate, fig. 46. represents a kidney-bean, opened to show the parts; *a*, the corculum; *b*, the plumula, or ascending part; *c*, the rostellum, or descending part; *d*, the lobes. 47. A seed with a calyculus or crown; the wild teazel. 48. A seed with a downy coronula; the thistle. 49. An echinated or prickly seed; the carrot.

The RECEPTACLE is the seat or base upon which all the other parts of the fructification are fixed and combined. Thus, if we take a flower, and pull off the calyx, the blossom, the nectary, the stamina, the pistils, the seed-vessel, and the seeds, the remaining part, at the top of the stalk, is the receptacle. In many flowers the receptacle is not a very striking part, but in others it is altogether large and remarkable; thus in the artichoke, after we have taken away the leaves of the calyx, the blossoms, and the chaffy or bristly substances adhering to the embryos of the seeds, the part remaining, and so much esteemed for food, is the receptacle. Its distinctions or ap-

pellations are as follow : A *common* receptacle, is that which connects many florets in such an even manner upon its surface, as that the pulling away any of them would cause a chasm or gap. The *palea* is a thin chaffy substance, springing from the receptacle to part the florets.

Umbella, an umbel, is a receptacle which, from one common centre, runs out into many filiform or thread-shaped footstalks of proportionate lengths. It is called a *simple* umbel, when it has no subdivisions; a *compound* umbel, when each footstalk is terminated by an *umbellula*, or little umbel; and, in this case, the umbel that bears the umbellula on its footstalks, is called an *universal* umbel; and the umbellula, which proceeds from the universal umbel, a *partial* umbel. *Cyma*, or cyme, is a receptacle that runs into long fastigiata footstalks, proceeding from the same universal centre, but with irregular partial ones. *Spadix*, is a receptacle which grows out of a spatha or sheath; and may be either branched, as in palms, or a plane simple pillar, as in dragon, or wake-robin.

With regard to the different *Structures* of the receptacle, it is only in the class which contains the compound flowers that these variations are necessary to be considered. In respect to its *Figure*, it is either *plane*, or flat, as in milfoil, and marigold; *convex*, or rounding, as in dandelion, and feverfew; or *conic*, shaped like a cone, as in chamomile, and purple Rudbeckia. In respect to *Surface*, it is either *naked*, as in feverfew; *punctate*, dotted, as in goat's-beard, dandelion, and marigold; *villous*, shaggy, as in downy sow-thistle; *setaceous*, bristly, as in blue-bottle; or *paleaceous*, chaffy, as in gosmore, purple Rudbeckia, and chamomile. In some simple flowers the fruit has separate receptacles, as in laurel-leaved tulip-tree, ovaria, and Michelia. Fig. 50, Plate VIII. represents a common receptacle; flat, punctate, or dotted; the *calendula-officinalis*, or common marigold.

gold. 51. A conic, paleaceous, receptacle, beset with chaffy scales which separate the florets; the purple *Rudbeckia*. 52. A receptacle of the fruit, having a central column, on which the fruit is seated. 53. An umbel, simple, the peduncles rising from one centre of the receptacle; the tooth-leaved androsace.

Such are the parts that enter into the composition of a flower; and these we shall now bring together into one view, and briefly recapitulate, for the more immediate instruction of the learner. For this purpose, and to furnish an example of the scientific investigation of a plant, we have selected the blue passion-flower, represented at fig. 54 of the same plate; where *a a*, is the *involucrum*, proper, stationed at a little distance from the flower, trifoliate, sessile, or without footstalks, concave, coloured. *b b*, The *calyx*: a perianthium monophyllous, quinque-partite, the segments somewhat ovate, carinate or keel-shaped on the under side, the keel ending in a hooked bristle, coloured. *c c*, The *corolla*: pentapetalous, semi-lanceolate, plain, blunt. *d d*, The *nectarium*: coronated, divided into rays, surrounding the pistillum. *e e*, The *filamina*: the filaments five, subulate or awl-shaped, reflex, fixed to the column, and growing together at the base; the antheræ oblong, obtuse, incumbent. *f f*, The *pistillum*: the styles three, short, club-shaped, coloured, spreading: the stigmas three, convex, capitate, nearly reniform, plumose. *g*, The *germen*, which becomes the *pericarpium*: unilocular, or having but one cell; the seeds numerous, ovate, arillate, nesting, or lying loose in the pulp. *h*, The *receptacle* of the fruit; a long, straight, cylindrical, column.

From the foregoing investigation of the parts composing a flower, we are led to conclude, That the essence of every vegetable consists in its fructification: the essence of the fructification consists in the flower and the fruit; the essence of the flower con-

sists in the antheræ and stigma: the essence of the fruit consists in the seeds. That the seed is a deciduous part of a plant, fraught with the rudiments of a new plant, and quickened by the pollen. That the anthera is the male organ that produces and discharges the pollen. That the pollen is the vivifying spark that produces impregnation, though not distinguishable by the naked eye. That the filament is the medium which elevates the anthera, and connects it to the vegetable, forming together the stamina. That the stigma is the female organ, which receives the pollen, and conveys it to the germen. That the style is the medium which elevates the stigma, and connects it with the germen. That the germen is the rudiment of the pericarpium, or of the fruit not yet arrived at maturity; its existence as a germ being chiefly at the time when the anthera is discharging its pollen; and that these three constitute the pistillum. That the calyx and corolla are the teguments or covers of the stamina and pistillum. That the pericarpium is an organ contrived for the purpose of protecting and maturing the seeds: and that the receptacle is the base connecting and supporting all the other parts in their natural order.

From these data, the following principles are deducible: 1. That every vegetable is furnished with flower and fruit, there being no species where these are wanting. 2. That there is no fructification without anthera, stigma, and seed. 3. That the anthera and stigma constitute a flower, whether the covers are present or wanting. 4. That the seed constitutes a fruit, whether there be a pericarpium or not. Thus much for the essential parts of flowers; we shall next consider their divisions.

Complete flowers are either simple, or aggregate. Simple flowers differ from aggregate in this, that they have not any part of fructification common to many flowers, as is the case with aggregate. Flowers are called

called aggregate, when many *flosculi*, or florets, are, by the mediation of some part of the fructification common to them all, so united, that no one of them can be taken out without destroying the form of the whole, of which it made a part. The common part in aggregate flowers is either the receptacle, or the calyx. A partial flower of the aggregate one is called *flosculus*, a floret. Aggregate flowers are primarily divisible into seven kinds, viz. 1. The *Aggregate*, properly so called. 2. The *Compound*. 3. The *Umbellate*. 4. The *Cymous*. 5. The *Amentaceous*, 6. The *Glumous*. 7. The *Spadiceous*. All which we shall explain.

An *aggregate* flower, properly so called, has a receptacle that is *dilate*, extended in breadth, the florets standing on peduncles, or footstalks, as in scabious, *Brunia*, *Barreria*, thrift, and laciniated teazel.

A *compound* flower is an aggregate one comprehending many florets that are sessile, squatted, or without peduncles, placed on a common receptacle that is entire, and having also a common perianthium, but furnished with antheræ that grow together in the form of a cylinder, as in dandelion, xeranthemum or eternal flower, the sun-flower, and marigold. The properties of a compound flower are, 1. A common receptacle, enlarged and undivided. 2. A common perianthium, surrounding all the florets. 3. The florets monopetalous and sessile. 4. The antheræ of each floret, five in number, and growing together in a cylinder. 5. A monospermous germen under each of the florets.—Of these properties the two last are essential to a compound flower; but there are some whose calyx contains only a single floret, as globe-thistle, base Egyptian elychrysum, corymbium, and wormwood.—Compound flowers are also of three kinds: *Ligulate*, when all the corollulæ, or little florets, are plain, flat, shaped like a narrow tongue, strap, or fillet, and expanded towards the outer side. *Tu-*
bulous,

tubulous, when all the corollulæ of the florets are tubulous, and nearly equal. *Radiate*, having rays, when the corollulæ of the disk, or middle parts, are tubulous, and those of the circumference, or margin, of another form, as in marigold, and sun-flower; which variation affords three cases, viz. when the corollæ of the circumference are either *ligulate*, as in milfoil; *tubulous*, but unlike the tubulous florets of the disk, as in blue-bottle; or *naked*, as in wormwood and cudweed. A compound flower consists of many florets, but rarely of a determinate number. A learner might easily confound them with the double flowers, from the similarity of their appearance; but by a little attention, and observing that the florets which compose the blossoms of a compound flower are long, narrow, and very differently constructed from the petals of double flowers, this difficulty will quickly be removed.

An *umbellate* flower is an aggregate one, consisting of many florets placed on a receptacle, on fastigiata peduncles that are all produced from the same point. A *simple umbel* is when the receptacle is but once divided into peduncles; a *compound umbel* is when all the common peduncles are subdivided into *umbellulæ*, or little umbels; an *umbellula* is therefore a *partial umbel*. Umbellate flowers, properly so called, have the following properties: 1. A common receptacle divided into peduncles in the manner above mentioned, whether the umbel produced be plane, convex, or concave. 2. A germen under the corollula. 3. Five distinct stamina that are deciduous. 4. A bifid pistillum. 5. Two seeds joined at the summits. A *radiate umbel* is when the marginal petals are larger than those of the disk, as in hart-wort of Crete, base parsley, coriander, bishop's-weed, and some species of cow-parsnip; an umbel may vary also in having the flowers of the margin differing in sex from those of the disk, as in black master-wort, base parsley, Artedia,

Arteria, water-dropwort, and shepherd's needle. The *involucrum* also varies, it being either *tetraphyllous*, of four leaves, as in water navel-wort, base stone-parsley, and cummin; *pentaphyllous*, of five, as in hare's ear, shepherd's needle, and Macedonian parsley; *heptaphyllous*, of seven, as in lovage; *decaphyllous*, of ten, as in Arteria: with the partial *involucrum dimidiate*, or going but half round, as in fool's parsley, coriander, and fanicle; or *caducous*, falling off, as in fennel-giant, and cow-parship.

A *cymous* flower is an aggregate one, of many florets, placed on a receptacle upon fastigate peduncles, the primary ones issuing from the same centre as in an umbel; but the secondary or partial ones lie dispersed, yet so as that the flowers they support form an even surface; which circumstance distinguishes the *cyma* from the umbel, as in serpent's-tongue, sweet-william, and the pliant mealy-tree.

An *amentaceous* aggregate flower has a filiform or thread-shaped receptacle, along which are disposed amentaceous squamæ or scales, that form an amentum of catkin, as in smaller burdock, ambrosia, base feverfew, false jesuit's-bark-tree, birch-tree, willow, black and white poplar-tree, hazel-nut-tree, hornbeam-tree, walnut-tree, beach-tree, chesnut-tree, and fig-tree.

A *glumous* aggregate flower has a filiform receptacle, the base of which is furnished with a common glume or husk, as in broom-grass, fescue-grass, vernal-grass, oats, reed, quaking-grass, meadow-grass, hair-grass, dog's-tail-grass, rope-grass, &c.

A *spadiceous* aggregate flower is, when there is a receptacle common to many florets placed within a spathe or sheath; such a receptacle is called a *spadix*, and is either branched, as in palms, or simple: in this last case the florets may be disposed either all round it, as in scunk-weed, and dragon; on the lower part of it, as in cuckow-pint; or on one side of it,

as in zostera, or grass-wrack. Next to these are the double flowers.

A flower is said to be *double*, or luxuriant, when some of the parts of fructification are augmented in number, and others thereby excluded. The luxuriance is chiefly owing to the abundance of its nourishment; the part multiplied is usually the corolla, but sometimes the calyx also; and by this increase of the covers, the essential parts of fructification are destroyed. Luxuriant flowers are divisible into, 1. *Multiplicate*, or multiplied. 2. *Pleni*, or full. 3. *Proliferous*, producing young. To which may be added, 4. *Mutilate*, or such as are deficient in some part, which stand opposed to the luxuriant ones.

Flowers are said to be *multiplicate*, when by the increase of the corolla, only a part of the stamina are excluded; and this distinguishes them from the *flores pleni*, or full flowers, in which the multiplication of the corolla is so great as to exclude them all. Multiplicate flowers are distinguished into duplicate, triplicate, quadruplicate, &c. that is, having a double, treble, or quadruple, series of rows, according to the number of the repetitions of the corolla. The polypetalous flowers are most subject to multiplication; the monopetalous are multiplied likewise, but it is very uncommon to meet with them full. A coloured perianthium, though it may have the appearance of a repetition of the corolla, ought not to be considered as such; for, though this appearance is in some degree monstrous, it is no multiplication.

A flower is said to be *plenus*, full, when the corolla is so far multiplied as to exclude all the stamina, as was before observed. This plenitude is occasioned by the stamina running into petals, with which the flower is so crowded as frequently to choak the pistillum also. The parts essential to generation being thus destroyed in full flowers, it is evident they must be barren; wherefore no good seed is to be expected
from

from them. Plenitude is chiefly incidental to polypetalous flowers, as in pear-tree, almond-tree, myrtle, rose, ranunculus, anemone, columbine, poppy, peony, pink, carnation, lily, crown-imperial, &c. Plenitude of monopetalous flowers is by some authors held a contradiction: but this cannot be granted; for there are instances of it in meadow-saffron, crocus, hyacinth, and polyanthes: however, it is rare that their luxuriancy passes duplicity. When they are filled, it is by the multiplication of the segments; whereas the polypetalous flowers are usually filled by the multiplication of the petals.

Flowers are said to be *proliferous*, when one blossom grows out of another: this generally happens in full flowers, the fullness being the cause of their becoming proliferous. Prolification happens in two ways: 1. From the centre. 2. From the side.—Prolification from the *centre*, which occurs in simple flowers, is when the pistillum shoots up into another flower standing on a single peduncle; of which there are instances in the pink, carnation, ranunculus, anemone, and rose. Prolification from the *side*, which happens in aggregate flowers, properly so called, is when many pedunculate flowers are produced out of one common calyx; of which there are instances in the daisy, marigold, hawkweed, and scabious. In umbellate flowers, the prolification is by the increase of the umbellulæ, one simple umbellula producing another, as in cornelian cherry; and in this manner compound umbels will become *supradecomposed*, more than compounded a second time, as in milk-parsley. A proliferous flower is called *frondous*, or leafy, when it produces leaves; this rarely happens, but instances of it have been found in roses, anemone, and others.

Mutilate flowers are the reverse of luxuriant. Linæus confines the term to those flowers only that want the corolla, and that ought to be furnished with it; which often happens in bell-flower, violet, colt's-

foot, and the berry-bearing chickweed. The cause of this defect he ascribes chiefly to the want of sufficient heat. The luxuriance of the calyx is very unfrequent, but not without instances: in *dianthus caryophyllus* there is a variety, in which the squamæ or scales of the calyx are so multiplied, as to constitute a perfect spike in a manner most singular: the graminæ or grasses of the Alps become fall by their glume shooting out into leaves, as in a species of the fescue-grass; and in *salix rosea*, and *plantago rosea*, the squamæ of the amentum of the former, and the bractæ of the spike in the latter, will shoot into leaves also.

In the Botanical Plate IX. a figure of each kind of the above-mentioned flowers is delineated, as follows: Fig. 1. A simple flower; the blossom of the theobroma; or chocolate-nut-tree. 2. An aggregate flower, properly so called; the lacinated teazel. 3. A compound radiated flower; the common marigold. 4. An universal compound umbellate flower; the bupleurum; or hare's ear. 5. A cymous flower; the sweet-william. 6. An amentaceous flower; the bloom of the white poplar. 7. A glutinous flower; the bloom of the vernal grass. 8. A spadiceous flower; the dwarf palm. 9. A monopetalous double flower; the variegated carnation hyacinth. 10. A polypetalous double flower; the poppy.

The manner in which flowers are attached to the plant, or the form in which they throw out their blossoms, is called *Inflorescence*; and these forms are distinguished by the following appellations, viz. a *spica*, or spike; a *racemus*, or bunch; a *verticillus*, or whirl; a *panicula*, or panicle; an *umbellata*, or umbel; a *corymbus*, or cluster; a *thyrsus*, or clustered bunch; and an *amentum*, or blooming catkin.

The *spike* is an assemblage of flowers growing upon one common footstalk, sessile, or sitting close upon the stem without peduncles, and running up narrow like an ear of corn, as shown at fig. 11. the *verbena orubica*. The *raceme* is a spike or bunch of flow-

BOTANY.

Plate IX.





The different Forms or Divisions of Flowers.

London, Published at the Art Directors, July 1879, by J. Wilson.

J. Wilson del.

ers, similar in form to the above, but, instead of being sessile, the blossoms hang by a slender peduncle, like grapes or currants; as the hyacinth, fig. 9. The *whirl* is a tuft of flowers growing round the stem, and proceeding from each axilla or joint made by the leaves or branches; as shown at fig. 18. the black horehound. The *panicle* is an assemblage of bloom scattered on peduncles variously subdivided, as at fig. 18. the avena, or wild oat. The *umbel* is a composition of flowers, in which a number of slender footstalks proceed variously from the same centre, and rise nearly to the same height, as at fig. 4. the huplecurum. The *corymbus* is a collection of blossoms somewhat resembling a bunch of ivy-berries, the flowers in which have each its proper pedicellus, or partial footstalk, elevating the whole to nearly an equal height; as at fig. 14. the Virginian gilder-rose, or spiræa. The *thyrsus* is an assemblage of flowers consisting of many clusters, growing together in a kind of ovate form, as at fig. 15. the lilac. The *amentaceous inflorescence* consists of a series of blossoms, or bloom coming out with, or upon, a catkin, as at fig. 6, the white poplar. Whether the flowers come single or double, these terms are the same in their application.

Many flowers, under the influence of garden-culture, are made to grow double, which are rarely found so in a wild state. When we recollect that every plant is composed of an outer bark, an inner bark, a wood, and a medulla or pith; when we reflect that the stamens are formed of the woody substance; and that this woody substance was originally formed by many coats of the inner bark consolidated; we shall not be at a loss to account for the mode of producing double flowers. The woody extremity, instead of running up into stamens, is expanded into petals. This appears to be effected by giving the plants an unaccustomed degree of succulent nourishment,

ment, which prevents the particles that form the wood from coalescing, and becoming solid. Hence it is that the flowers with many stamens are most apt to become double, and to a greater degree, than those which have few. Double flowers, and those of a brilliant colour, are doubtless desirable objects to the florist; but with the botanist they have little weight; for double flowers, being repugnant to nature, are regarded as monsters; and the colour of the petals, though ever so bright, are considered only as external covers, primarily designed to protect the more essential parts. It must, however be allowed, that plants whose colours are permanent, might be made to afford the readiest marks of distinction; and perhaps it is not a vain imagination to believe, that a display of beauty was in some measure the design of the Creator.

OF THE SEXUAL OR LINNÆAN CLASSIFICATION.

THE sexual classification being now universally admitted, it were useless for us to enter into the merits of the controversy about it, further than briefly to mention those arguments which were adduced by Linnæus in favour of its establishment. For this purpose he first attempted to show, that vegetables are endowed with a certain degree of life; and, secondly, that they propagate their species in a manner similar to that of animals. That vegetables are really living beings (says he), must be obvious at first sight; because they possess the properties contained in that accurate definition of life laid down by Dr. Harvey; namely, *Vita est spontanea propulsio humorum*. Now universal experience teaches, that vegetables propel humours or juices: hence it is plain that vegetables must be endowed with a certain degree of life.

Not trusting solely to a syllogism founded on a definition, Linnæus proceeds to support the life of vegetables

vegetables by arguments drawn from the following particulars in their economy.

1. *Nutritio*.—The very idea of nutrition implies a propulsion of humours, and of course the idea of life. Now vegetables derive their nourishment from the earth, air, &c. and consequently must be considered as living creatures.

2. *Ætas*.—Every animal must not only *begin* to exist, and have that existence dissolved by death, but must likewise pass through a number of intermediate changes in its appearance and affections. Infancy, youth, manhood, old age, are characterised by imbecility, beauty, fertility, dotage. Are not all these vicissitudes conspicuous in the vegetable world? Weak and tender in infancy; beautiful and salacious in youth; grave, robust, and fruitful, in manhood; and when old age approaches, the head droops, the springs of life dry up, and, in fine, the poor tottering vegetable returns to that dust from whence it sprung.

3. *Motus*.—No inanimate body is capable of self-motion. Whatever moves spontaneously is endowed with a living principle: for motion depends on the spontaneous propulsion of humours; and wherever there is a spontaneous propulsion of humours, there also is life. That vegetables are capable of motion, is evident from the following facts: Plants, when confined within doors, always bend towards the light, and some of them even attempt to make their escape by the windows. The flowers of many plants pursue the sun from east to west, rejoicing in his beams. Who then can deny that vegetables are possessed of living and self-moving powers?

4. *Morbus*.—The term *disease* means nothing more than a certain corruption of life. It is well known that vegetables are subject to diseases as well as animals: when over-heated, they turn thirsty, languish, and fall to the ground; when too cold, they are tormented with the chilblain, and not unfrequently expire;

pire; they are sometimes afflicted with cancers; and every plant is infested with lice peculiar to its species.

5. *Mors*.—Death is opposed to life, the former being only a privation of the latter. Experience shows, that every living creature must die. But as vegetables are daily cut off by internal diseases and external injuries; as they are subject to death from the attacks of hunger, thirst, heat, cold, &c. with what propriety could vegetables be thus said to die, unless we allow that they previously lived?

6. *Anatomia*.—Under this head Linnæus refers to Malpighius and Grew, for the organic fibres, membranes, canals, vesicles, &c. of plants, as additional proofs of their living powers.

7. *Organizatio*.—Vegetables not only propel humours, but also prepare and secrete a number of different juices for the fruit, the nectar, &c. analogous to the various secretions in animal bodies.

From these facts and observations Linnæus concludes, that plants are unquestionably endowed with life as well as animals; and then proceeds in the following manner to show how these animated vegetables propagate their species.

After discussing the long exploded doctrine of equivocal generation, he lays hold of another maxim of Dr. Harvey, viz. *Omne vivum ex ovo*. It being fully evident, (says he) from the foregoing chain of reasoning, that vegetables are endowed with life, it necessarily follows, agreeable to this maxim of Harvey, that every vegetable must in like manner derive its existence from an egg. As vegetables then proceed from eggs, and as it is the distinguishing property of an egg to give birth to a being similar to that which produced it, the seeds must of course be the eggs of vegetables. Granting then that the seeds of vegetables are intended by nature to answer the same end as the eggs of animals, and considering at the same time that no egg can be fecundated without receiving an impregnation

impregnation from the male, it follows, that the seeds or eggs of vegetables cannot be fecundated by any other means. Hence the necessity of vegetables being provided with organs of generation. But where are these organs situated? The answer is easy: we have already found impregnated seeds within the flowers of plants; and it is natural to expect that the *genitalia* should not be at a greater distance. Now, as copulation always precedes birth, and every flower precedes the fruit, the generating faculty must be ascribed to the flower, and the birth to the fruit. Again, as the antheræ and stigmata are the only essential parts of flowers, these parts must necessarily be the organs of generation.

Being thus far advanced, Linnæus affirms, that the antheræ are the *testes*, and that the pollen performs the office of the *male semen*. These affirmations he endeavours to establish by the following arguments:

1. *Præcedentia*. The antheræ, or vegetable testes, always precede the fruit; and, as soon as the antheræ come to maturity, which constantly happens before the maturity of the fruit, they continue to throw out their pollen as long as the flower lasts; but decay and fall off whenever the fruit comes to perfection.
2. *Situs*. The antheræ of all plants are uniformly situated in such a manner that the pollen may with the greatest facility fall upon the stigma, or female organ.
3. *The Tempus*. The antheræ and stigma always flourish at the same time.
4. *Loculamenta*. When the antheræ are dissected, they discover as great a variety of structure as the pericarpia or seed-capsules: for some of them have one cell, as the mercury; some two, as the hellebore, &c.
5. *Castratio*. If all the antheræ be cut off from an hermaphrodite plant, just before the flowers begin to expand, taking care at the same time that no plant of the same species grow near it, the fruit will either prove entirely abortive, or produce barren seeds.
6. *Figura*. When the pollen

of

of different plants is examined by the microscope; it exhibits as great a variety of figures as is discoverable in the seeds themselves.

The accumulated force of these arguments (concludes Linnæus) amounts to a full demonstration that the antheræ are the testes, and that the pollen is the semen or genitura of vegetables.

The male organ being thus investigated; he imagines that none will hesitate to pronounce the stigma to be the *female organ*, especially when the following observations are sufficiently attended to. The pistillum is composed of the germen, stylus, and stigma. The germen, being only a kind of rudiment of the future foetus or seed, ceases to exist as soon as the flower comes to maturity. Neither is the stylus an essential part, as many flowers have no stylus. But no fruit ever comes to maturity without the assistance of the stigma. It follows, that the stigma must be the female organ adapted by nature for the reception of the pollen, or impregnating substance. This will appear still clearer from the following chain of reasoning.

1. *Situs*. The stigmata are always situated so that the pollen may with most ease fall upon them. Besides, it is remarkable, that in most plants (though not in all) the number of the stigmata exactly corresponds with the loculamenta or cells of the pericarpium. 2. *Decidentia*. The stigmata of most plants; like the antheræ, decay and fall off as soon as they have discharged their proper function; which evidently shows, that their office is not to ripen the fruit, but solely to answer the important purpose of impregnation. 3. *Abscissio*. The argument here is precisely the same with the castration of the antheræ; and the result is likewise the same, namely, the destruction of the fruit.

These arguments (concludes Linnæus) are sufficient to demonstrate, that the stigma is the female organ

gan of generation, or that organ which is suited for the reception and conveyance of the semen to the vegetable eggs. Hence plants may be said to be in *actū veneris*, when the antheræ or *testiculi* spread their pollen over the stigma or female *vulva*.

To show how the *coitus* of vegetables is effected, is the next object of investigation. He affirms, that the pollen is conveyed, by means of the wind or insects, to the moist stigma, where it remains until it discharges a subtle fluid, which, being absorbed by the vessels of the stigma, is carried to the seeds or ova, and impregnates them. His proofs are taken from the following particulars.

1. *Oculus*. When the flowers are in full blow, and the pollen flying about, every one may then see the pollen adhering to the stigma. This he illustrates by mentioning as examples the tricoloured violet, flower-de-luce, bell-flower, &c. 2. *Proportio*. The stamina and pistilla, in most plants, are of equal heights, that the pollen, by the intervention of the wind, may, with the greater facility, fall upon the stigma. 3. *Locus*. The stamina of most plants surround the pistillum, to give the pollen an opportunity of falling upon the stigma at every breeze of wind. 4. *Tempus*. It is also remarkable that the stamina and pistilla constantly appear at the same time. 5. *Pluvia*. The flowers of most plants expand by the heat of the sun, and shut themselves up in the evening, or in rainy weather. The final cause of this must be to keep the moisture from the pollen, lest it should be thereby coagulated, and of course prevented from being blown upon the stigma. 6. *Palmicola*. That the cultivators of palm-trees were in use to pull off the spadices from the males, and suspend them over the spathæ of the females, is attested by Theophrastus, Pliny, Prosper Alpinus, Kempfer, and many others. If this operation happened to be neglected, the

dates were abortive, and destitute of nuts. Kempfer adds this singular circumstance, that the male spadix, being thoroughly dried and kept till next season, still retained its impregnating virtue. 7. *Flores nutantis*. As the pollen is specifically heavier than air, such flowers as have their pistillum longer than the stamina, hang down, or incline to one side, as in the crown-imperial, bell-flower, &c. An easy admission of the pollen to the stigma is the final cause of this appearance. 8. *Submersi*. Many plants that grow below water emerge when their flowers begin to blow, and swim upon the surface till they receive their impregnation, and then sink down. 9. *Omnium florum genuina consideratio*. Here a number of particulars are recited. We shall confine ourselves to those that are most striking and applicable to the subject.

When the flowers of the male hemp are pulled off before those of the female are fully expanded, the females do not produce fertile seeds. But as a male flower is sometimes found upon a female plant, this may be the reason why fertile seeds are sometimes produced even after this precaution has been observed. The tulip also affords another experiment of the same kind. Cut off all the antheræ of a red tulip before the pollen is emitted; then take the ripe antheræ of a white tulip, and throw the pollen of the white upon the stigma of the red; the seeds of the red tulip, being thus impregnated by one of a different complexion, will next season produce some red, some white, but most variegated, flowers.

Linnaeus likewise published a description of a new genus, which he called *Peloria*, on the supposition of its being a hybrid or mule plant, i. e. a plant produced by an unnatural commixture of two different genera. The root, leaves, caulis, &c. of this plant, are exceedingly similar to those of the antirrhinum linaria, a species of snap-dragon; but the flower and other parts

parts of the fructification are totally different. On account of its similarity to the linaria in every part of the flower, Linnæus imagined it to have been produced by a fortuitous commixture of the linaria with some other plant, although he was never able to point out the father. In the third volume of the *Amœnitates Academicæ*, there is a complete dissertation, intitled *Plantæ Hybridæ*, wherein the doctrine of *vegetable mules* is much extended. This dissertation contains a list of forty-seven mules, with their supposed fathers and mothers. For example,

The *Veronica spuria*, a species of speedwell, is said to be a mule plant, begot by the *Verbena officinalis*, a species of vervain, upon the *Veronica maritima*, another species of speedwell.

The *Delphinium hybridum*, a species of larkspur, is a mule begot by the *Aconitum napellus*, a species of wolf's-bane, upon the *Delphinium elatum*, another species of larkspur.

The *Arctotis calendula*, a mule begot by the *Calendula pluvialis*, a species of marigold, upon the *Arctotis triftis*.

The *Asclepias nigra*, a species of swallow-wort, is a mule begot by the *Cynanchum acutum*, a species of dog's-bane, upon the *Asclepias vincetoxicum*, another species of swallow-wort.

From the examples given in this dissertation, Linnæus draws this conclusion, That only two species of each genus existed *ab origine*; and that all the variety of species which now appear, have been produced by unnatural embraces betwixt species of different genera.

Under this head, Linnæus likewise quotes from Ray the story of Richard Baal, gardener at Brentford. This Baal sold a large quantity of the seeds of the *brassica florida* to several gardeners in the suburbs of London. These gardeners, after sowing their seeds in the usual manner, were surprised to find them turn

out to be plants of a different species from that which Baal made them believe they had purchased; for, instead of the *brassica florida*, the plants turned out to be the *brassica longifolia*. The gardeners, upon making the discovery, commenced a prosecution of fraud against Baal, in Westminster-hall. The court found Baal guilty of fraud, and decreed him not only to restore the price of the seeds, but likewise to pay the gardeners for their lost time, and the use of their ground. "Had these judges (says Linnæus) been acquainted with the sexual hypothesis, they would not have found Baal guilty of any crime, but would have ascribed the accident to the fortuitous impregnation of the *brassica florida* by the pollen of the *brassica longifolia*."

He next proceeds to celebrate the utility of insects, because they convey the pollen of the male to the stigma of the female. "In this way (says he) it is reasonable to think that many plants are impregnated; for, by their fluttering and treading in the corolla, they are constantly scattering the pollen about the stigma. From this circumstance, gardeners who raise early cucumbers derived the idea of putting the anthera of the male blossom into the female corolla; otherwise the fruit generally falls off, and proves abortive, there being no insects in February and March to perform this office. Other gardeners, on a sunny day, will procure bees from the hive, and shut them into their frames, for the purpose of conveying the pollen to the female flower, which is generally found to succeed in producing good and early fruit. Upon the whole, (concludes Linnæus,) the coitus of vegetables is evident to a demonstration. This coitus is nothing more than the conveyance of the pollen to the stigma, to which it adheres till it bursts, and discharges a subtile elastic fluid. This fluid or aura is absorbed by the vessels of the stylus, and carried directly to the ovarium or germen, where the

the mysterious work of impregnation is fully completed."

After thus insisting on the sexual conformation of flowers, Linnæus proceeds to distinguish plants by these organs into male, female, hermaphrodite, androgynous, and polygamous.

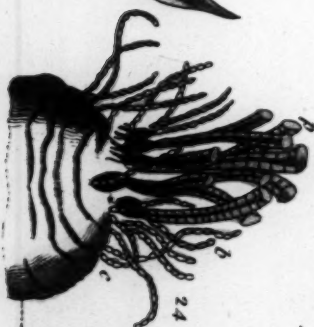
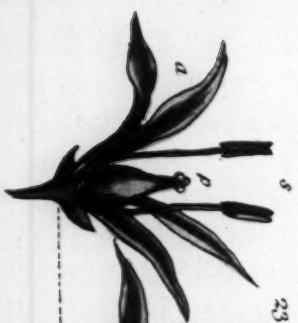
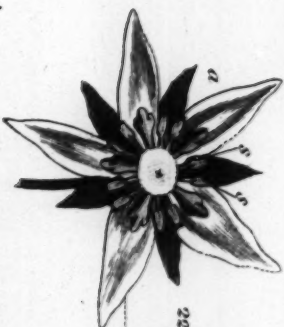
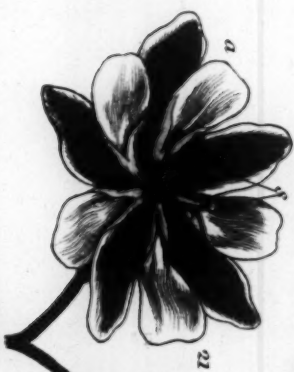
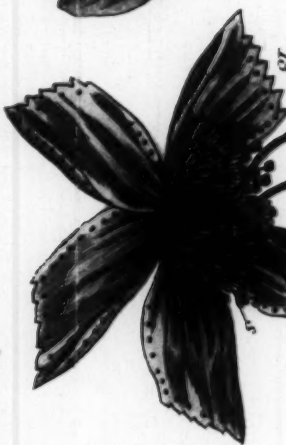
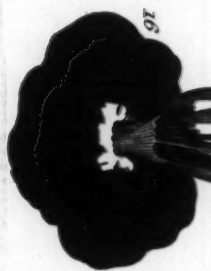
Male plants, are such as upon the same root bear male flowers only; that is, such as have the anthera, but not the pistillum; as in the palm or date tree above referred to. *Female*, are such as in like manner bear female flowers only on the same root, having the pistillum, but not the anthera; as in the female date-tree. *Hermaphrodite* plants are such as upon the same root bear only hermaphrodite flowers; that is, such as have both anthera and pistillum incorporated in one blossom; which is the case with the generality of vegetables. Hermaphrodites are also sometimes distinguishable into *male* hermaphrodite and *female* hermaphrodite; this happens when, although the flower contains the parts proper to each sex, one of them proves abortive or ineffectual; if the defect be in the stamina, it is a *female* hermaphrodite; if in the pistillum, a *male* one. *Androgynous* plants, are all such as have upon the same root both male and female flowers; that is, some of the blossoms containing the anthera only, and some the pistillum only; as in triplacum, and triple-headed pond-weed. *Polygamous* plants, are such as either on the *same* or on *different* roots, bear hermaphrodite flowers, and also flowers of either, or of both, the sexes. Of plants that are polygamous on the *same* root, there are three cases: First, *male* hermaphrodite, and *female* hermaphrodite flowers; which is a very rare case, but is observed in the plantain-tree. Second, *hermaphrodite and male* flowers, as in white hellebore, lote or nettle tree, hard grass, and cross-wort. Third, *hermaphrodite and female* flowers, as in pellitory, and the sea-purslane-tree. Of such

as are polygamous on *two distinct roots*, the cases are four: First, *hermaphrodite* flowers and *male*, as in ginseng, tupelo-tree, and the Indian date-plum. Second, *hermaphrodite* flowers and *female*, as in the ash-tree. Third, *hermaphrodite* flowers and both *male* and *female*, as in three-thorned acacia. Fourth, *androgynous* and *male*, as in artichop. Of plants that are polygamous on *three distinct roots*, there is but one case, viz. *hermaphrodite*, *male*, and *female*, as in the fig-tree. The instance of this case given in the *Philosophia Botanica* of Linnæus, is the berry-bearing heath; but in a note in the last edition of the *Genera Plantarum*, we are informed, that the hermaphrodite flowers which the author had once seen on a plant of this genus, could never afterwards be found again; we have therefore changed that example for the *figus* or fig-tree, the only other instance left of this very remarkable case.

It is the foregoing specific distinctions in the sexes of plants, that Linnæus hath assumed as the foundation of his systematic arrangement. From the number, figure, situation, and conformity, of these parts, he divides all the vegetable productions upon the surface of the globe, into *Classes*, *Orders*, *Genera*, *Species*, and *Varieties*. The classes are compounded of orders; the orders are composed of genera; the genera of species; and the species admit of many varieties.

To give a familiar idea of this mode of classification, no comparison can be more in point, than that which considers the vegetables upon the face of the earth, as analogous to its inhabitants; thus,
VEGETABLES resemble the **INHABITANTS** in general;
CLASSES - resemble the **NATIONS**;
ORDERS - resemble the **TRIBES**;
SPECIES - resemble the **INDIVIDUALS**;
VARIETIES are the same *Individuals* differently apparelled.

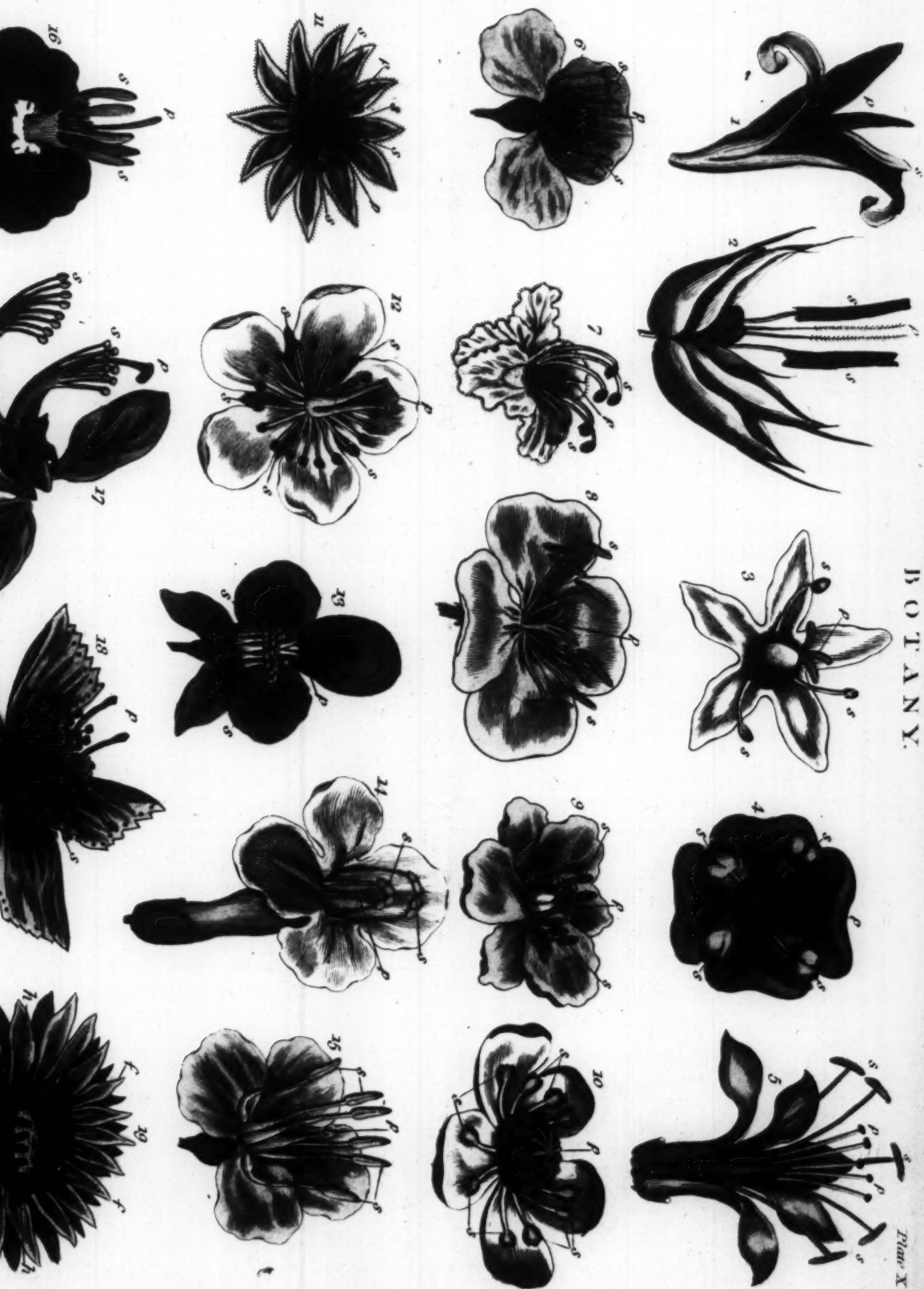
The



The Twenty-four Species of Yucca.

London: Printed and sold by J. G. Smith, in Pall Mall.

BOTANY.



The characters of the *Classes* are taken either from the number, the length, the connection, or the situation, of the stamina, or *male* organ. The *Orders* are named chiefly from the number of the pistillum, or *female* parts, but in some cases from other circumstances of the fructification. The *essential* characters or marks of the *Genera*, are taken from some particulars in the flower, by which they can be constantly known and distinguished. The *Species* are generally characterized from some peculiarities in the stem or leaves; sometimes from certain parts of the flower; but rarely from the roots. *Varieties* are such individual plants as differ but little from their species; and of which they always carry some obvious mark, either in shape, colour, taste, or smell.

The number of classes into which Linnæus divides the whole vegetable kingdom, is twenty-four; and each of these he subdivides into a certain number of orders, as in the following statement; where the figures at the beginning show the number of each class, and refer to the corresponding figures in the Botanical Plate X: where a flower is delineated and appropriated to each respective class, showing its peculiar formation, or classical character, viz.

CLASSES AND ORDERS.

1. MONANDRIA; having *one* stamen in each flower, as shown at fig. 1. in the Plate,—Subdivided into Two Orders, viz. Monogynia and Digynia.
2. DIANDRIA; *two* stamina in each flower, as at fig. 2.—Subdivided into Three Orders: Monogynia, Digynia, and Trigynia.
3. TRIANDRIA; *three* stamina in each flower, as at fig. 3.—Subdivided into Three Orders: Monogynia, Digynia, and Trigynia.
4. TETRANDRIA; *four* stamina in each flower, all of the same height, as at fig. 4.—Subdivided into

- into Three Orders: Monogynia, Digynia, and Trigynia.
5. PENTANDRIA; *five* stamina in each flower, the antheræ not united, as at fig. 5.—Subdivided into Six Orders; Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, and Polygynia.
 6. HEXANDRIA; *six* stamina in each flower, all of the same height, as at fig. 6.—Subdivided into Five Orders: Monogynia, Digynia, Trigynia, Tetragynia, and Polygynia.
 7. HEPTANDRIA; *seven* stamina in each flower, as at fig. 7.—Subdivided into Four Orders: Monogynia, Digynia, Trigynia, and Tetragynia.
 8. OCTANDRIA; *eight* stamina in each flower, as at fig. 8.—Subdivided into Four Orders: Monogynia, Digynia, Trigynia, and Tetragynia.
 9. ENNEANDRIA; *nine* stamina in each flower, as at fig. 9.—Subdivided into Three Orders; Monogynia, Trigynia, and Hexagynia.
 10. DECANDRIA; *ten* stamina in each flower, as at fig. 10.—Subdivided into Five Orders; Monogynia, Digynia, Trigynia, Pentagynia, and Decagynia.
 11. DODECANDRIA; *from twelve to nineteen* stamina in each flower, as at fig. 11.—Subdivided into Five Orders; Monogynia, Digynia, Trigynia, Pentagynia, and Dodecagynia.
 12. ICOSANDRIA; *twelve* stamina or *upwards*, fixed to the calyx or petals, as at fig. 12.—Subdivided into Five Orders; Monogynia, Digynia, Trigynia, Pentagynia, and Polygynia.
 13. POLYANDRIA; *twenty* stamina and *upwards*, as at fig. 13.—Subdivided into Seven Orders; Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Hexagynia, and Polygynia.
 14. DIDYNAMIA; *four* stamina, *two long*, and *two short*,

- short*, as at fig. 14.—Subdivided into Two Orders: Gymnospermia, and Angiospermia.
15. **TETRADYNAMIA**; *six* stamina, four *long*, and two *short*, as at fig. 15.—Subdivided into Two Orders; Siliculosa, and Siliquosa.
16. **MONADELPHIA**; in which class all the filaments of the antheræ are united, as at fig. 16.—Subdivided into Eight Orders; Triandria, Pentandria, Octandria, Enneandria, Decandria, Endecandria, Dodecandria, and Polyandria.
17. **DIADELPHIA**; the filaments of the antheræ united in one or two sets, as at fig. 17.—Subdivided into Four Orders; Pentandria, Hexandria, Octandria, and Decandria.
18. **POLYADELPHIA**; the filaments united in *three* or more sets, as at fig. 18.—Subdivided into Three Orders; Pentandria, Icosandria, and Polyandria.
19. **SYNGENESIA**; *five* stamina, distinct at the bottom, united at the top, as in fig. 19.—Subdivided into Six Orders; Polygamia æqualis, Polygamia superflua, Polygamia frustranea, Polygamia necessaria, Polygamia segregata, and Monogamia.
20. **GYNANDRIA**; the stamina growing out of the style, or upon an elongated receptacle, as at fig. 20.—Subdivided into Eight Orders; Diandria, Triandria, Tetrandria, Petandria, Hexandria, Decandria, Dodecandria, and Polyandria.
21. **MONOECIA**; the stamina and pistillum separated, and placed in two distinct flowers, as at fig. 21.—Subdivided into Eleven Orders; Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Heptandria, Polyandria, Monodelphia, Syngenesia, and Gynandria.
22. **DIOECIA**; the stamina and pistillum growing on separate roots or plants, as at fig. 22.—Subdivided

vided into Fourteen Orders; Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Enneandria, Decandria, Dodecandria, Polyandria, Monadelphia, Syngenesia, and Gynandria.

23. POLYGAMIA; the stamina and pistillum are both conjoined, and also *separate*, on the *same* or on *different* roots; as at fig. 23.—Subdivided into Three Orders; Monoecia, Dioecia, and Trioecia.

24. CRYPTOGAMIA; the stamina and flowers are wholly inconspicuous. This class is subdivided into Four Orders, viz. Filices, Musci; Algæ, Fungi. The characters of a male and female flower from the Order *Musci*, is exhibited at fig. 24, as they appear through a very strong magnifier; *a*, the male; *b*, the female; it is the bryum extinclorium. To which Linnæus adds, as an *Appendix*, the PALMÆ, or order of *Palms*. We now proceed to

AN EXPLANATION of the CLASSES and ORDERS.

MONANDRIA, is a term compounded of the Greek *μῆνός*, *unicus*, one, and *ἀνὴρ*, *maritus*, a husband, or male; so that Linnæus intended to express by this title, that all the flowers in the class monandria have but *one* male organ, or stamen. And finding, upon a scrutiny into the flowers of this class, that some of them were possessed of *one* pistillum, and others of *two*, it became necessary to distinguish these, and to separate them, by appropriate names, into Two Orders; so that the *first* of these flowers would be composed of one stamen and *one* pistillum. Here then we see the foundation of classes and orders. The *first* order, *Monogynia*, he likewise denominated from the Greek *μῆνός*, *one*, and *γυνή*, *mulier*, a wife, or female; denoting, that flowers of this order have only *one* pistillum, or *female* part; so that, “class Monandria, order Monogynia,”

hogynia," denotes a plant whose flower or fructification has only *one* stamen, and *one* pistillum; as exemplified in the Botanical Plate X. fig. 1. where *s* is the stamen, and *p* the pistillum; it is a blossom of the canna, or Indian flowering reed. The *second* order, *Digynia*, is in like manner compounded of the Greek words importing *two* females; and denotes that this order of flowers is possessed of *two* pistilla, or female organs, as shown at *p*, fig. 2. Let it be constantly recollected, that all those flowers, possessing both male and female organs, are termed *hermaphrodite*.

DIANDRIA, from *dis*, twice, and *andros*, a husband, or male; imports in like manner that all flowers of this class are possessed of *two* stamina, or *male* organs; as at fig. 2. which shows the class Diandria, order Digynia: it is the fructification of the vernal grass, considerably magnified to show the parts distinct: *s s*, the stamina; *p*, the pistillum. But, as the flowers composed of two stamina were also found to have among them some with one, some with two, and some with *three*, pistilla, it became necessary to introduce a *third* order into this class, termed *Trigynia*, which should comprehend the flowers with *three* pistilla, or female organs; as shown at *p*, fig. 3.

TRIANDRIA, compounded likewise of the Greek term for *three* males, denotes that class of plants whose flowers have *three* stamina. And these having either one, two, or three, *pistilla*, the class is divided accordingly into the three orders corresponding thereto. Fig. 3. shows the class Triandria, order Trigynia; *s*, the stamina; *p*, the pistilla. It is the verticillate mollugo, or African chickweed, magnified to distinguish the parts.

TETRANDRIA, by changing the numerical term to that denoting *four*, implies a class of plants whose flowers have *four* stamina or male organs, of *equal length*. In this class, some of the flowers have *one*, others *two*, and some *four*, pistilla; hence the two

first orders are Monogynia and Digynia; but the *third* order in this class, to express the four pistilla, is termed Tetragynia, i. e. *four females*. Fig. 4 expresses this case; class Tetrandia, order Tetragynia; *s*, the stamina; *p*, the pistilla. This example is a very curious construction of the parts; it is a fructification of the Potamogeton, or common pondweed, considerably magnified.

PENTANDRIA, in like manner, denotes *five* males; it is therefore used to distinguish those plants whose flowers have *five* stamina. And as the flowers of this class are constructed either with one, two, three, four, five, or *many*, pistilla, they are of course divisible into *six* orders; so that in addition to the four orders above explained, we have now two additional ones to add, viz. Pentagynia, containing flowers with *five* pistils; and Polyginia, containing flowers with *many*, or with a cluster of pistils. A flower of the fifth class and fifth order, viz. Pentandria Pentagynia, is delineated at fig. 5. *s*, the stamina; *p*, the pistilla: it is the crassula, or African navel-wort.

HEXANDRIA; this term signifies *six* males; it therefore implies that class of plants whose flowers have *six* stamina, *all of the same length*. The flowers in this class are formed either with one, two, three, four, or *many*, pistilla; the orders are therefore of the same denomination as those above explained: only the *sixth* order, Polyginia, in the Pentandria class, is the *fifth* in this. An example of the class Hexandria, order Polyginia, is shown at fig. 6. *s*, the stamina; *p*, the clustered pistilla: it is a fructification of the alisma, or great water plantain, very much magnified.

HEPTANDRIA, denotes that class of hermaphrodite plants whose flowers contain *seven* stamina, or male organs. The flowers are also constructed with either one, two, four, or *seven*, pistilla; whereby the order Heptagynia, denoting *seven females*, occurs only

only in this class. A delineation of the class Hep-
tandria, order Monogynia, is given at fig. 7. *s*, the
stamina; *p*, the pistilla: it is a blossom of the *Æscu-
lus*, or horse-chestnut.

OCTANDRIA, denotes those plants whose flowers
are compounded of *eight* male parts, or stamens. The
females have either one, two, three, or four, pistils,
common to each flower; so that the four orders, ex-
pressive of these four cases, are all that belong to this
class. A representation of the class Octandria, order
Monogynia, is given at fig. 8. *s s*, the stamina; *p*,
the pistillum. It is the *Cenothera*, or tree-primrose.

ENNEANDRIA, signifies *nine* males; it is therefore
characteristic of that class of plants whose blossoms
contain *nine* stamina. In these flowers are also found
either one, three, or *six*, pistilla; the corresponding
orders are therefore Monogynia, Trigynia, and Hexa-
gynia. The class Enneandria, order Hexagynia, is
shown at fig. 9. which is the *Butomus*, flowering-rush,
or water gladiole; *s s*, the stamina; *p*, the pistillum.

DECANDRIA, is a term denoting *ten* males; it
therefore represents the class of plants whose fructifi-
cation has *ten* stamina, or male organs. The flow-
ers in this class are formed either with one, two,
three, five, or *ten*, pistilla; the order Decagynia is
therefore now added to those before explained, de-
noting *ten* females. This class Decandria, order De-
cagynia, is delineated at fig. 10. *s*, the stamina; *p*,
the pistilla: it is the *Phytolacca*, or American night-
shade.

DODECANDRIA, denotes *twelve* males, and it is
therefore used as characteristic of twelve stamina. The
class, however, is not confined to that number, but
includes all such hermaphrodite flowers as are fur-
nished with any quantity of stamina from *twelve* to
nineteen inclusive. No flowers have yet been found
to have precisely *eleven* stamina, which is the reason
no class has been allotted to that number. The
flowers

flowers in this class have either one, two, three, five, or *twelve*, pistilla: the order *Dodecagynia* is therefore now introduced, to denote the *twelve females*. Fig. 11. represents the class Dodecandria, order Dodecagynia: *s*, the stamina; *p*, the pistilla: it is the fructification of the *Sempervivum*, or great houseleek.

ICOSANDRIA; this term signifies *twenty males*; and therefore denotes those plants whose blossoms have twenty stamina. But here again the term is to be understood within a certain latitude; for, though the plants of this class are rarely ever found with *less* than twenty stamina, yet they frequently have a greater number. They are therefore not always to be known with certainty from those of the next class, without having recourse to their essential character, which we shall explain under the head of the genera. The flowers of this class being formed with either one, two, three, five, or *many*, pistilla; the orders corresponding thereto are already explained. An example of the class Icosandria, order Digynia, is given at fig. 12. *s*, the stamina; *p*, the pistilla: it is the *Cratægus*, or white bean-tree.

POLYANDRIA, denotes *many males*; it is consequently used in this place to distinguish that class of plants whose blossoms have *many* stamina, from twenty to a thousand. The flowers are constructed either with one, two, three, four, five, six, or *many*, pistilla; the seven orders, therefore, corresponding to these numbers, and which have been already explained, belong to this class. A delineation of the class Polyandria, order Trigynia, is given at fig. 13. *s*, the cluster of stamens; *p*, the pistilla: it is the *Aconitum*, or wolf's-bane.

DIDYNAMIA; this term denotes the *power* or *superiority* of *two*; and is applied to this class, because the flowers have four stamina, *two* long, and *two* short. This circumstance is alone sufficient to distinguish this class from the fourth, wherein the four stamina are

are always of an *equal* length. Of the three orders of this class, the two first are founded upon a distinction in the fruit; for the flowers bear only one pistillum each. The title of the first order, *Gymnospermia*, is expressive of such plants as have *naked* seeds; and that of the second, *Angiospermia*, of such as have their seeds in a pericarpium. These will be fully demonstrated in the engravings given to illustrate the genera. The third order, *Polypetala*, is expressive of such flowers as have *many petals*. This order seems to have been established in favour of one genus of plants only, the *melianthus*, the flowers of which are polypetalous, though those of all the rest of this class are monopetalous. The class Didynamia, order Gymnospermia, is represented at fig. 14. *s*, the stamina; *p*, the pistillum: the balm-leaved melittis.

TETRADYNAMIA, is a term which in the Greek expresses the power or superiority of *four*; and is made use of in this place to denote all those plants whose blossoms have six stamina, *four* of which are *higher*, or *superior* to the other two; which circumstance distinguishes them from plants of the sixth class, where the six filaments are of *equal* height. The two orders in this class, viz. *Siliculosa* and *Siliquosa*, derive their names and distinctions from the pericarpium. In the first order, the pericarpium is a *silicula*, or bivalvular pod, of a round or oval form, or whose transverse diameter is equal, or nearly so, to its longitudinal; and having the apex of the dissepiment, which had first been the style, prominent beyond the valves. The second order is distinguished by a pericarpium which is a *siliqua*, or long pod, consisting of two valvulæ, in which the seeds are fixed alternately to each future. Miller improperly applies this definition to the legumens, or pulse. A delineation of the class Tetradymania, order *Siliculosa*, is given at fig. 15. *s*, the stamina; *p*, the pistillum: it is the blossom of the annual lunaria, or moonwort.

wort. The pericarpia will be figured in the plates appropriated to the genera.

MONADELPHIA, from *μονος*, one only, and *αδελφος*, brother; is a term used to express the consanguinity of one brother. It is chosen in this place to denote the union of the filaments of the stamina, which in this class do not stand separate, but are all formed from one substance at the base, out of which they proceed as from a common mother; and the title of the class, importing only a *single* brotherhood, shows that there is but *one* set of stamina so united, which distinguishes the class from the two that follow. The number of the stamina is not limited; but the orders are founded on the number of the stamina contained in the brotherhood or set: which admitting of eight variations in this class, the eight orders into which it is consequently divided, are named from the titles of the early classes in the system, which denote the respective number of stamens contained in each. An example is given at fig. 16. which illustrates the class Monadelphia, order Dodecandria: *s*, the set of stamens; *p*, the pistillum: it is the Pentapetes, or Indian vervain mallow.

DIADELPHIA; this term expresses a *double* brotherhood; or that class of plants whose flowers bear *two* sets of stamina, united in the manner explained in the preceding class. The number of the stamina is not limited; but the four orders into which the flowers are divided, are expressive of the number in each brotherhood, and are named, in the same manner as above, from the early classes in the system. A representation of the class Diadelphia, order Octandria, is delineated at fig. 17. *ss*, the brotherhoods, or sets of stamens; *p*, the pistillum: it is a blossom of the myrtle-leaved Polygala, or milk-wort.

POLYADELPHIA, signifies *many* brotherhoods; and is used here to distinguish those hermaphrodite plants, whose blossoms contain many distinct sets of stamina.

This

This class is divided into three orders, expressive of the number of stamens contained in each set; and are synonymous with the names of three of the foregoing classes, from the aptness of their designation with these three cases of the united stamina. Fig. 18. illustrates the class Polyadelphia, order Polyandria: *s*, the *many* sets or clusters of stamina, which consist likewise of *many* stamina in a set, all growing together in the corolla; *p*, the pistilla; which in these classes only serve to show that all the flowers are hermaphrodite.

SYNGENESIA, is a term formed of *σύν*, together, and *γενεσις*, generation, including a *joint* or *compound* generation. It is the class under which the compound flowers are arranged; and is expressive of the *con-generation*, or connected form, of the stamina; in which, though the filaments are distinct and separate, yet the antheræ, which are the parts more immediately subservient to generation, are united in a cylindrical figure, and perform their office together. To understand the orders in this class, it is necessary to explain what is meant by *polygamy* in flowers. We have already treated of polygamous plants, in p. 101, and shown that the term polygamous, as there applied, alluded to the intercommunication of the male or female flowers with the hermaphrodite ones, either upon the same, or on a distinct plant of the same genus. But, in respect to the *flowers*, the term is applied to a single blossom only; for the flowers of this class being compound, a polygamy arises from the intercommunication of the several florets in one and the same flower. Now the *polygamy of flowers*, in this sense of the word, affords four cases, which are the foundations of the four first orders of this class. 1st Order, *Polygamia æqualis*, or equal polygamy, is when *all* the florets are hermaphrodite. 2d Order, *Polygamia superflua*, or superfluous polygamy, is when some of the florets are hermaphrodite, and

others female only; for, in this case, as the fructification is perfected in the hermaphrodites, the addition of the females is a superfluity. 3d Order, *Polygamia frustranea*, or frustraneous or ineffectual polygamy, is when some of the florets are hermaphrodite, and others neuter; for, in this case, the addition of the neuter is of no assistance to the fructification. 4th Order, *Polygamia necessaria*, or necessary polygamy, is when some of the florets are male, and the rest female; for, in this case, there being no hermaphrodites, the polygamy arising from the composition of the florets of different sexes is *necessary* to perfect the fructification. 5th Order, *Polygamia segregata*, signifies *to be separated*, the plants of this order having partial cups growing out of the common calyx, which surround and divide the flosculi or florets. 6th Order, *Monogamia*, signifies a *single* marriage, and is opposed to the polygamy of the four first orders; for in this, though the antheræ are united, which is the essential character of the plants of this class, the flower is *simple*, and not compounded of many florets, as in the other orders.—A delineation of the class Syngenesia, order Polygamia superflua, is given at fig. 19. *h*, the hermaphrodite corollulæ, occupying the whole centre, or disk; *f*, the female corollulæ, placed round the hermaphrodites, which have, in this example, five stamina and one pistillum. It is the *Xeranthemum*, or eternal flower.

GYNANDRIA, from *gyn*, a woman, and *andros*, a man, denotes a *male and female*; it is therefore used here to express the singular construction of the fructification in this class of plants, in the flowers of which the stamina grow upon the pistillum in such a manner, that the male and female parts are united, and do not stand separate, as in the other hermaphrodite flowers. The *orders* in this class, being founded on the number of stamina produced in the different flowers, the names have been selected from the appropriate titles of

of the classes, and applied as in some of the preceding cases. Fig. 20. exhibits a delineation of the class Gynandria, order Triandria; *s*, the stamina; *p*, the pistillum: it is the *Silyrinchium*, or *Bermudiana*.

MONOECIA, from *μονος*, one, and *οικος*, a house; denotes a *single* house or habitation. But to understand the application of this term in the present instance, we must recollect, that the flowers produced by this class of plants are *not* hermaphrodites, but *androgynes*; the blossoms that have the stamina wanting the pistillum; and those that have the pistillum wanting the stamina. Now the term *Monoecia*, by denoting a *single* habitation, alludes to this circumstance: that the male and female flowers of this class are both found in the same plant or dwelling; whereas, in the next, they have *distinct* habitations. The orders in this class are founded upon the number of stamina produced in the different flowers, which consist of eleven divisions; they are therefore distinguished by eleven titles from the classes, which denote their respective number of stamens. A representation of the class Monoecia, order Gynandria, is given at fig. 21. *a*, the male flower; *s*, the stamina; *b*, the female flower; *p*, the pistilla. It is the *Andrachne*, or bastard orpine.

DIOECIA; this word, by the variation of the numerical term, denotes *two* houses or dwellings; and is applied to this class of plants, whose flowers are male and female, to express the circumstance of the male flowers growing on one plant, and the female on another; so that the presence of both plants is necessary to propagation. The orders, like those in the class Monoecia, are founded on the number of stamina present in the blossoms, which admit of *fourteen* divisions; they are consequently named from fourteen titles of the classes, which import their respective number of stamens. Fig. 22. illustrates the class Dioecia, order Decandria: *a*, the blossom produced

duced by the *male* plant; *s*, the *stamina*; *b*, the flower produced by the *female* plant; *p*, the *pistilla*: it is the *Kiggelaria*.

POLYGAMIA, formed of *πολυς*, many, and *γαμος*, nuptials, denotes a *plurality* of marriages. So the class thus denominated produces, either upon the same or on different plants of the same genus, hermaphrodite flowers, and also flowers of one sex only, be it male or female; or else flowers of each sex; and the latter receiving impregnation from, or giving it to, the hermaphrodites, as their sex shall happen to be, the parts essential to generation in the hermaphrodite flowers do not confine themselves to the corresponding parts within the same flower, but become of *promiscuous* use; which is the reason of giving the above title to the class. It contains three orders, the two first of which are the same with the titles of the twenty-first and twenty-second classes, and are to be understood in the same manner, viz. *Monoecia*, when the polygamy is on the *same* plant; and *Dioecia*, when it is on *two distinct* plants. The third order, *Trioecia*, has been established in favour of a single genus, the *figus*, in which the polygamy is on *three distinct* plants. Fig. 23 exhibits the class Polygamia, order Dioecia: *a*, is a blossom from the hermaphrodite plant; *s*, the *stamina*; *p*, the *pistillum*; *b*, is a blossom from the female plant; *p*, the *pistillum*: it is the *Fraxinus*, or flowering ash.

CRYPTOGAMIA, compounded of *κρυπτος*, concealed, and *γαμος*, nuptials; denotes a concealment of marriage; and the term is made use of in this place, because all the plants of this class either bear their flowers concealed *within* the fruit, or have the parts of fructification so extremely minute, as to be imperceptible to the naked eye. The *figus*, whose flowers are borne within the fruit, was originally placed in this class, but Linnæus removed it into the polygamia, on account of the spreading *umbilicus*, or opening

ing of the receptacle, and polygamous construction of its florets. The orders in this class consist of four very different kinds of plants, viz. the Filices, or ferns; the Musci, or mosses; the Algæ, or sea-weeds, and other aquatic plants; and the Fungi, or mushrooms. Fig. 24. is a very curious delineation of the class Cryptogamia, order Musci: *a*, the male fructification; *s*, the stamina; *b b*, the succulent threads or vessels rising from the base of the stamina; *c*, the female flower; *p*, the pistilla. Fig. 25. exhibits the order Filices; it is the under side of three leaves of the polypodium, or fern, magnified to show the flowers or fructification, which are disposed in rows on each side the mid-rib: here the seeds, exceedingly minute, are fostered and matured, as in a pericarpium. Fig. 26. the order Algæ; showing the fructification of the scarlet fucus. The Fungi will be exhibited in the engravings appropriated to the genera.—Also, the PALMÆ, or order of *Palms*; whose singular structure occasioned their being thus placed together under a distinct head. A figure of one of these plants is given in the Botanical Plate IX. fig. 8. it is the Chamærops, or dwarf palm.

Such are the Classes and Orders which constitute the celebrated Sexual System of Linnæus;—a system, which perhaps has contributed more to the elucidation and improvement of the science of Botany, than all the joint discoveries and communications of former writers. Some later botanists, however, of considerable eminence, have mutually agreed to abolish the classes *Gynandria*, *Monoecia*, *Dioecia*, and *Polygamia*, under an impression that it will tend to simplify the study, and disburthen the memory from a great number of unnecessary applications of the terms. Under this new arrangement, the orders contained in the classes thus abolished are incorporated and dispersed among the other nineteen classes, according to the number of their stamina, as projected by Linnæus himself.

himself. The *Palms*, in the Appendix to the Cryptogamia class, are also distributed in a similar manner; so that the system now in vogue, and which seems almost universally to obtain, consists only of the first nineteen classes, and the Cryptogamia class, making twenty in the whole. Dr. Withering, in his Arrangement of British Plants, published in 1796, has adopted this abridged system, after the powerful example of the learned Dr. Gmelin of Gottingen, and with the approbation of Sir Charles Thunberg, successor to the great Linnæus in the botanical professorship in the university of Upsal. But concerning the *utility* of this departure from Linnæus's plan, the editors of the Monthly Review, in their *critique* upon Dr. Withering's useful and valuable work, have remarked as follows:

“ Much may be said every way with respect to the abolition of the classes Gynandria, Monoecia, Dioecia, and Polygamia, as to the necessity and the use of so doing. Some naturalists, of late, have imagined that they have experienced obstructions in the attainment of botanical knowledge, from the perplexity of those classes, and have accordingly removed them; but the question remains to be decided whether they have facilitated the study of them. They who remove these classes, and incorporate the several genera under them into the other classes, according to their stamina, are still observed to retain the distinction of the old class under which Linnæus had arranged them. Of what import is it, then, on the first view of this matter, whether any plant stand in this or that class; if, after all, the gynandrous, monoecious, dioecious, or polygamous, flower is to be the mark of distinction? It appears to us that the difficulty is increased by the anomaly being dispersed throughout so many classes. Heretofore, the sight of a monoecious flower at once referred us to a certain class, which comprised all plants of that appearance.

ance. Now we are to be aware that every class may have these irregularities. We cannot but therefore deem this an increase of confusion.

“ Let us only observe the symmetry of the Linnæan system. The first nineteen classes bear flowers, of which the stamina, how different soever in number, situation, proportion, &c. all surround the pistillum, and are distinct from it. In the twentieth, they are situated *on* it. As, then, situation is so important a feature in the sexual frame, how could Linnæus (*si sibi constet*) have done otherwise than have thrown those plants, the fructification of which is so singularly constituted, into a separate class? Again, the class Monoecia exhibits flowers totally distinct from all which have gone before. On the same plant appear some flowers purely male, and others altogether female. The sexual system is so very materially affected here, that the distinction cannot be disguised. This class is founded on natural character. Linnæus appears to us to have been compelled to follow it. A still stronger difference is to be found in the class Dioecia. The fructification is completed by the efforts of two distinct plants. Thus, in all the willows, the female flowers are produced by one tree, the male by another. Here is such a departure from the general laws of production, that it must be noted. It would have militated against all the golden aphorisms of the *Philosophia Botanica*, to have passed over these circumstances in silence. At once the whole doctrine of situation, the very life of the sexual system, must have been done away; and the system itself must have tottered from its foundation. The sexual system, it is true, is highly artificial; yet not so much so but that it studies to coincide with nature, and is conscious that it is in its highest glory, when it falls in most completely with those orders which nature herself has constituted. Here it cannot but be anticipated by every good botanist,
how

how much of natural order is visible in each of these three classes.

“ It must be admitted that the class Polygamia has not apparently so much to urge in its own behalf, as those classes which have just been mentioned: for, whatever anomaly appears in some flowers, all plants, having always likewise hermaphrodite and regular flowers, might have been arranged in the other classes, according to the number of their stamina, &c. It must also be admitted, that there is nothing of natural order observable in the plants of this class: but, so far from any defect, the construction of this class has always appeared to us an argument of the soundness and firmness of mind which the illustrious Swede was known to possess. None of those who have thought proper to set aside these classes have advanced the science. All that was done has been to throw into several classes that which Linnæus, in perfect conformity with the laws of his own system, confined to one. However men complain, the same monstrosity, the same marks of polygamous distinction, are to be adopted.—*Idem oculi lucent, eadem feritates imago.* Certainly Linnæus, by constructing this class, rounded, if we may so say, the sexual system. He argued that every separate feature deserved a separate name. He numbered these features, and taught us to call them by their names.” Monthly Review for January 1797.

In offering these remarks, the editors candidly disclaim the intention of throwing any censure upon Dr. Withering, or upon any of those who are gone before him; their design being only to submit these hints to the consideration of others. For our own part, we profess to give our readers the Linnæan arrangement in its original form, as indispensable to every learner of botany, whatever improvements or alterations the science may afterwards receive. Therefore, having fulfilled our duty in pointing out the
abolition

abolition of these classes, and the removal of the orders into different parts of the system, we shall proceed to state the *genera*, according to the principles laid down by Linnæus.

Of the GENERA of PLANTS.

* The *Genus*, or *Genera*, of plants, is the second subdivision in the Linnæan System, and comprehends an assemblage of species, whose similarity of parts and structure requires them to be placed under the same class and order; out of which subordinate *species* and *varieties* proceed. The foundation of all generic distinctions, resides in the differences observable in the structure of the flowers and fruit. Hence all vegetables that agree in their parts of fructification, are to be put together under one genus; and all such as differ in those parts, are to be divided. The characteristic mark of each genus, is to be fixed from the number, figure, proportion, and situation, of all the parts. But, as there are few genera wherein all the parts are constant in every one of the species, we are obliged, wherever it is possible, to fix upon some one well-known single circumstance that is constant, and this constitutes what is termed the *classic* or *essential* character. This in most genera may be readily found: thus, the essential character of self-heal, eye-bright, madwort, and sea-cabbage or kale, lies in the denticles of the stamina; that of turmeric, humming-bird tree, Bignonia, and Martynia, in a mutilate stamen; the ranunculus is distinguished by its nectarium, which is a pore in the claws of its petals; hydrophyllum, or water-leaf, by the same part, which in that genus is a closed chink in the lacinia of the corolla; and hellebore, and funnel-flower also, by their tubular nectaria; in sea-daffodil, the stamina are inserted in the nectarium, which distinguishes it from narcissus; in henbane, there is a covering to the capsules, by which its known from winter-cherry; the mignonette

has always a lateral nectarium, but varies in its corolla and pistillum; the bell-flower has a quinque-valved nectarium, but is inconstant in the corolla and capsule; and lastly, the flower-de-luce has a stigma of singular construction, but varies in the beard of its corolla.

There is, however, no one part of fructification that can be relied on as a *constant* characteristic mark for *all* genera; it being found, that the part which is constant in some genera will be inconstant in others: thus, in the papaw-tree, the flowers of the male plant are monopetalous, and those of the female pentapetalous; in candle-berry myrtle, some species have naked seeds, others berries; in the ash-tree, some have a naked flower, and others a corolla; in geranium, some have regular corollæ, and others irregular; in flax, some are pentapetalous, others tetrapetalous; in wolf's-bane, some are tricapfular, and others quinquecapsular; and in trefoil or clover, some are monopetalous, others polypetalous, some monospermous, and others polyspermous. This inconstancy of particular parts in many genera, has been a great source of error amongst the earlier botanists, who have parted many plants from their congeners on this account.

When the characteristic mark of any genus is wanting in any particular species, we should proceed with caution, lest we confound genera that should be distinguished. For want of this caution, the common heath and base heath had been joined, but were parted afterwards on account of the two horns in the antheræ of the common heath; the adonis or pheasant's-eye had been joined to the ranunculus, but was parted from it again, on observing that it wanted the nectariferous pore; and the aloe and agave had been blended, till it was observed that in the latter the stamina were inserted in the corolla, and not in the receptacle. When the characteristic mark of any
genus

genus is observed in some species of another genus near of kin to it, a like caution is necessary on the other hand, lest we should multiply the genera by parting species that should stand together: thus we find, that in stone crop, houseleek, rose-root, smaller orpine, small annual houseleek, and navel-wort, the nectaria adhere to the base of the pistillum; in willow-herb and tree-primrose, the calyx is tubular; in the medlar-tree, wild service-tree, and garden-service, the structure of the flower is alike; and in both alnus and betula or birch-tree, there are three florets on the foliole of the amentum.

The more constant any part of the fructification is found to be through the several species of any genus, the more it may be relied on with certainty as a characteristic mark for that genus. Thus in *hypecoum* the nectarium is constant, but not the pod; the lily of the valley is constant in its spotted berry, but not in its corolla; the cardinal-flower in its corolla, but not in its fruit; the wild senna in its corolla, but not in its pod; and the vervain in its calyx and corolla, but not in its stamina and seeds. In some genera one part of the fructification is found to be the most constant, and in others another; but there is no part that is not liable sometimes to a variation: thus we find the pericarpium variable in balsam, bell-flower, primrose, poppy, rock-rose, fumitory, and strawberry-tree; the calyx in water-lily and dog-wood; the corolla in bilberry, lily of the valley, base heath, gentian, and flax; and the seeds in *ranunculus* and water-plantain.—If the flowers agree, but the fruits differ, the genus ought not to be parted: thus, in those extensive genera, the senna, French honeysuckle, mallow-tree, Syrian mallow, and sensitive plant, so great a number of species have been ranged under the same genus, on account of the conformity in the flowers, though there is a variation in the fruit.

That the figure of the flowers is more certain than

that of the fruit, appears from many examples: as from the bell-flower, primrose, snap-dragon, water-plantain, Syrian mallow, rock-rose, &c. but the proportion of the parts is subject to great variation. The *number* of the parts is more liable to variation than their figure, and is found sometimes to vary even upon the same plant; as in rue, golden saxifrage, bird's-nest, spindle-tree, syringa, and moschatel; in the flowers of all which the number of the parts varies from five to four. In these doubtful cases, the natural number must be collected from the primary flowers; but in the variations of the *number* of the parts, there is a proportional affinity worth remarking: in flowers the stamina usually vary from ten to eight, and from five to four; the corolla and calyx from five to four; and the whole flower from four to three: and the fruit also usually varies from five to three, and from five to four.

The situation of the parts is the most constant, very rarely varying in the same genus. The regularity of the petals is not so much to be depended on as some former botanists have thought; for we see in geranium, the European species have regular corollæ, but the African ones irregular. The nectarium, nature has made of great consequence in determining the genus. It is a decisive mark in all the following genera, viz. in lizard-flower, butterfly-flower, bird's-nest, fumitory, violet, Malpighia, Banisteria, base flower-fence, day-flower, bay-tree, white dittany, bean-caper, marsh-gentian, lily, crown-imperial, water-leaf, crowfoot, Hermannia, barberry, bladder-nut, passion-flower, daffodil, sea-daffodil, marvel of Peru, rose-bay, African swallow-wort, African spiræa, bell-flower, lead-wort, hyacinth, dwarf rose-bay, mustard, Kiggelaria, balsam-tree, columbine, fennel-flower, wolf's-bane or monk's-hood, grass of Parnassus, barren-wort, chocolate-nut-tree, mignonette,

mignonette, Grewia, hellebore, isopyrum, Indian cress, and balsam.

The stamina and calyx, being less subject to luxuriance, are far more certain than the petals in deciding genera. The corolla varies as to its figure in many genera; as in whortle-berry, winter green, base heath, tobacco, bog-bean, primrose, speedwell, gentian, hyacinth, scabious, and daffodil. It varies also as to number, being in ranunculus pentapetalous in some species, and polypetalous in others; in hellebore also, pentapetalous and polypetalous; in thrift, pentapetalous and monopetalous; and in fumitory diapetalous and tetrapetalous: and the number is also sometimes variable in the same species; as is observed in the papaw-tree, and cassada. The structure of the pericarpium was formerly thought to be of great consequence in determining the genera; but there are examples without number that demonstrate its uncertainty.

The characters of luxuriant flowers, whether eunuchs, i. e. such as have lost the stamina, or mutilate, cannot be allowed any place in determining the genera; for in full flowers no number of petals can be assigned, and the stamina are generally wanting, the number of which makes a principal part of the generic character; and in mutilate flowers, as in some species of bell-flower, quamoclit, and ruellia, the corolla would be excluded from the description, contrary to the nature of the other species of the genus. But, as the calyx in full flowers is scarcely ever altered, it may detect the genus; and the lowest series of petals in polypetalous corollæ remaining the same in respect to number, the genus may also be often known by that character; as in the rose, the poppy, and fennel-flower.

OF SPECIES.

Species constitute the third subdivision in the Lin-
næan

næan system, which comprehends all the different forms of plants that are supposed to have been originally created. These plants, says Linnæus, have, by the established laws of nature, continued to produce others like themselves; therefore the *Species Plantarum* comprehends all the different invariable forms of plants which are found at this day upon the face of the earth.

We have shown the *generic* distinctions to depend on the form of the fructification, and to be confined to that alone. *Specific* differences take their rise from any circumstance, wherein plants of the same genus are found to disagree; provided such circumstance is constant, and not liable to alteration by culture or other accidents; for all casual differences are *varieties* of the same species. Towards the end of the seventeenth century, the desire of increasing the number of plants had so seized the botanists of that time, that new species were established on too slight differences, to the great detriment of the science; and the same eagerness led them also to set down as new genera, what should have been species only. This evil was in some measure unavoidable, whilst there were no fixed principles for the regulation of the science in this respect. A remedy for it was first attempted by Vaillant; afterwards by Jussieu, Haller, Royenus, Gronovius, and others; and lastly by Linnæus, whose aphorisms have brought the work much nearer to perfection. Something indeed seems still wanting to complete these doctrines; but perhaps more is not to be expected till this branch of natural philosophy receives farther assistance from experiment. We shall first point out those circumstances by which species are distinguished with certainty, and then show what are varieties.

The *root* will sometimes afford a real specific difference, as in squill, where the species are scarcely to be distinguished but by the bulbs being tunicate, solid,
or

or squamose ; and in the butterfly-flower, where the species are known by the roots being fibrous, round, or testiculate ; but, as access cannot always be conveniently had to this part of the plant, it is better to fix the specific distinction on some more obvious circumstance.

The *trunk* often furnishes a very sure mark of distinction. Thus in St. John's wort, lily of the valley, and French honeysuckle, there are many species distinguishable by the angles of the stem ; and in lupine, the species are not easy to be known, except by the same part being simple, or compound. In net-wort, the most remarkable difference is in the stem, which is quinquangular, hexangular, decangular, &c. In winter-green, some species are distinguished by a triquetrous stalk. In citrus, the aurantium is distinguished from its congeners by its petioles, which are winged or increased by a membrane on each side ; and in globe-amaranth, there is a species distinguished by its peduncles, which are diphyllous, being furnished with two opposite folioles which are placed under the head of the flowers.

The *leaves* exhibit most natural and also most elegant specific differences. These have been so amply treated of already, that it would be only repetition to particularize or exemplify the numerous cases that occur of such distinctions.

The *fulcra*, props or defences of plants, are generally good marks of distinction, and must be carefully attended to by the botanist for the determination of the species ; especially where the difference consists principally in those parts of the plant. Thus, the *aculei*, or prickles, are remarkable in the raspberry ; the *spines*, or thorns, in the plum-tree and hawthorn ; the *bractæ*, or floral leaves, in fumitory, dragon's-head, and the Indian species of French honeysuckle ; to which may be added the *coma*, which is a bushy head, composed of bractæ that are of a large

large size, and terminate the stem, in crown-imperial, lavender, and sage.

Glandules, or the secretory glands, furnish the essential mark in Indian mallow, sensitive-plant, wild fenna, and many other genera. These glands are found on the serratures at the *base* of the leaves, in sun-seed, willow, and the almond-tree; on the *back* of the leaves, in Indian mallow, and the passion-flower; and on the *aculei*, in *Bauhinea aculeata*, where by the apex of the aculei a liquor is secreted. The almond-tree is distinguished from *persea* only by the glandules of the serratures; nor could the species of the Indian mallow be ever fixed without examining the glandules of the leaves. The convolvulus with a tuberculate calyx, is so variable in the shape of its leaves, that it seems divisible into many species, yet it is kept together by the glandules: and there is a species of Oswego tea, distinguishable from its congeners by the glandules, that are sprinkled over the corolla.

The *stipulæ*, or small scaly leaves at the base of a leaf-stalk or fruit-stalk, are of great consequence in many extensive genera, where the species are liable to confusion. Thus in one species of the honey-flower the *stipulæ* are solitary; in the other they are in pairs; and the *castia auriculata* is rendered distinct from all its congeners by the shape of its *stipulæ*, which are reniform and barbate.

The *hybernacles*, or buds and bulbs of plants, also afford likewise a certain specific difference. That *germs* or buds often differ greatly in the same genus is proved by buckthorn; in which the various species *cervispina*, *alaternus*, *paliurus*, and *frangula*, have all a difference in their buds; and in that extensive and intricate genus the willow, the species are by the structure and foliation of the buds distinguished with great certainty. *Bulbs* also distinguish the species, as is proved by squill; and by their situation
in

in the axillæ of the leaves, they determine tooth-wort, lily, star of Bethlehem, saxifrage, and bistort.

The *inflorescence*, or mode of flowering, affords the truest and in most genera the most elegant distinction. Thus in *spiræa*, the flowers are in some species duplicate-racemous, in others corymbous, and in others again umbellate; without which characters there would be no certainty of the species. The *peduncle*, or flower-stalk, which is the foundation of the characters of inflorescence, varies as to the manner of its supporting the flowers; and is said to be *flaccid*, or wanting firmness, when it is so weak as to be bowed down by the weight of the flower itself; *cernuus*, or nodding, when it is incurvate at the apex, so that the flower inclines to one side, or towards the ground, and cannot preserve an erect posture, by reason of the strict curvature of the peduncle; as in carpesium, radiated agrimony, alpine scabious, annual sun-flower, and the musk-thistle, as shown in the Botanical Plate II. fig. 8.—Bearing *fastigiate* flowers, as when the pedicelli, or partial footstalks, elevate the fructification into a fascicle, so that they are of an equal height at the top, as if they had been shorn off horizontally; as in sweet-william and viscous campion. *Patulous*, or spreading; when it is branched out every way, so that the flowers stand remote from each other. This stands opposed to *coarctate*, or close. Bearing *glomerate* flowers; when it is branched, and bears the flowers in close compact heads, and is therefore opposed to a *diffuse* panicle. *Articulate*, or jointed; when it is furnished with a joint; as in Indian mallow, wood-forrel, and Syrian mallow. Coming out in *pairs*; as in sweet-weed and Oldenlandia biflora. *Tern*, or three from the same axilla; as in the three-flowered balsam. *Flexuose*, bending divers ways, or undulate, waved; as in flexuous hair-grass. *Remaining* on the plant after the fructification is fallen; as in jambolifera, ochna, and beetle-nut. *Incrassate*, or thickened

thickened towards the flower : as in May-weed, goat's-beard, and most cernuous flowers.

The parts of *fructification* often furnish most certain and constant specific differences. Linnæus tells us he was once of a contrary opinion; and held, that, as the flower was of short duration, and its parts commonly very minute, recourse should not be had to the fructification for specific differences, till all other ways had been tried and found ineffectual; but, as the fructification contains more distinct parts than all the rest of the plant taken together, and certitude is found throughout nature to depend mostly on her minuter parts, he has since readily admitted this distinction. In gentian, the species cannot any way be distinguished, if the flower is not admitted as a specific character; but they are easily distinguished by their corollæ, which vary in being campaniform, rotate, infundibuliform, quinquefid, quadrid, octofid, &c. In St. John's wort, the species are distinguished by the flowers being trigynous, i. e. with *three* styles or pistils; or pentagynous, with *five* pistils. In geranium, the African species are distinguishable from their European congeners, by the corolla being irregular, and also by the connection of their stamina. In liverwort, the fructification is distinguishable into *tuberculum*, a little knob, which is a fructification consisting of rough points collected like a heap of dust; *scutellum*, a small buckler, which is a concave orbiculate fructification, the margin of which is elevated on every side; or *pelta*, a little shield, which is a plane fructification fastened for the most part to the margin of the leaf. The terms used here respect such circumstances of the parts of the fructification as concern rather the *specific* differences than the *classic* or generic ones; and we have therefore followed Linnæus in subjoining them to this head, notwithstanding some few of them have been already mentioned and explained.

OF VARIETIES.

Varieties, in the classification of plants, constitute the fourth subdivision in the Linnæan system; and comprehend the various appearances observable in vegetables produced from the same seeds, offsets, and suckers. The causes of this variation in plants of the same species, are occasioned by the differences of climate, situation, or soil; and the difference of their appearance is either in magnitude, plenitude, shape, colour, taste, or smell. The ability of collecting and arranging these varieties under their proper species, is a work no less necessary than that of collecting the several species under their proper genus. We have already observed, that all such differences as are only incidental to vegetables, and not found constant and unchangeable in them, are to be considered as marks of varieties.

The *sex* of plants, in the class dioecia, affords a variety of all others the most natural; for the male and female flowers being upon different plants, these last are distinguished by the fructification, though the species is the same in both. But it must be observed, that this kind of variety holds only in the class dioecia; for in the genera that belong to any of the hermaphrodite classes, the same circumstance, whenever it happens, becomes a *specific* distinction: thus in dock, which belongs to the class hexandria, the species acetosa and acetosella, being dioecious plants, that is, having their male and female flowers on distinct roots, are thereby distinguished from the rest of the genus.

Magnitude affords no *specific* difference, but that of *variety* only; being liable to alteration from soil and climate. The *time* of flowering is a fallacious mark of a distinct species; and, unless supported by other distinctions, it can never be considered but as a variety. *Colour* also is often so changeable in the same

species, that it is considered as a mark of variety only. The flowers most prone to vary in their colour, are the tulip, violet, bell-flower, columbine, carnation, lily, fumitory, and a great number of others, which it would be tedious and useless to enumerate. The trifling distinctions which have been made by florists in some of the genera here instanced, from the mere colours of the corollæ, and to which they have given such pompous names, are considered by Linnæus as incompatible with the views of a true botanist; and he cautions him not to abandon the classical study of the science, for the idle amusement of flowers.

Fruits are observed to change their colour as they ripen; the pericarpium, when it is a berry, changing from green to red, and from red to white; and in ripe fruits, the colour, whether white, red, or blue, admits of variation; as in pears, plums, peaches, &c. *Seeds* rarely vary in their colour; though there are instances of it in poppy, oats, kidney-bean, pea, &c. *Roots* too are little subject to alteration in colour; yet a variation is observed in the roots of carrot and radish. *Leaves* are rarely found to quit their green, but they are coloured in amaranth, and frequently become spotted, as in ranunculus, butterfly-flower, hawkweed, and lettuce. The *whole plant* is often found to vary in its colour; as in sea-holly, mugwort, sea purslane tree, nodding amaranth, purslane, lettuce, cabbage, and kale.

Scent in plants is, of all other circumstances, the least to be depended upon; and therefore all species grounded on a distinction in the scent only, are to be rejected, and referred to varieties. *Taste* in vegetables is a circumstance variable from soil or culture; and not to be depended upon as a real difference, though it is more constant than scent. The distinction of gardeners in fruit of the *same* species, is considered by Linnæus as a variety too minute to enter
into

into the province of botany; and therefore the various names which have been given to these distinctions, are to be neglected as foreign to the science; though, for the purpose of gardening, they may have their use. The *virtues* and *uses* of plants furnish no specific difference; therefore the distinctions of physical writers, in this respect, cannot always be depended upon.

The *duration* of plants is no sure mark of distinct species, being often owing rather to the situation than to the nature of the plant. In warm regions, plants that are annual with us will become perennial or arborecent; as is found in Indian cress, beet, tree-mallow, &c. And, on the contrary, cold regions will occasion perennial plants to become annual; as is observed in palma Christi, marvel of Peru, &c. *Multitude*, or quantity, is an accidental circumstance in plants, and cannot conclude any thing more than variety, whether the increase be of the plant itself, or of its roots, stems, leaves, or fructification. *Pubescent*, or the downy surface of vegetables, is also an uncertain mark; as, by culture and change of soil, plants are subject to lose as well their spines as their hair or down, whereby they constitute so many varieties.

Leaves, though for the most part they furnish elegant *specific* differences, are yet subject to luxuriance in the same species, which must be carefully distinguished into varieties. This may respect their opposition and composition, and also their being crisp, curled, bullate, or bladdery. In respect to *opposition*, opposite leaves will sometimes become tern, quatern. or quine, growing by threes, fours, or fives; and then the stem also, from quadrangular, or square, will become polygonous, or of many sides. In respect to *composition*, digitate leaves will frequently gain an addition of one or more folioles. Crisp or curled leaves are a very frequent source of variety. In tan-

sey,

sey, mint, basil, and feverfew, which are scented plants, there is this singularity, that, the more the leaves are curled; the stronger the scent is found to be. Bullate, or bladdery leaves, are generally produced from such as are rugous, or wrinkled; and this is owing to the increase of the substance of the leaf within its vessels, which occasions it to swell and rise: in the English concave soap-wort, a bullate leaf is produced in a singular manner from the *defect* of wrinkles; for here, the margin of the leaf contracting itself, the leaves become hollow like a spoon. Plants are sometimes found to vary from broad-leaved to narrow-leaved; but this variation is less frequent.

Monstrous, or double flowers, such as the multiplicate, full, or proliferous, derive their origin from natural ones, and therefore are considered only as varieties from luxuriance. The change of soil and climate is found to have a great effect on the nature of plants; and to this many of the varieties above-mentioned must be referred; as in box-tree, lesser burdock, bear's-breech, self-heal, mouse-ear, honey-wort, and most cultivated herbs and flowers, which would all return to their old condition whenever they came to be neglected. So in like manner the improvements which are made in the plants cultivated for the table, as the vine, pear, plum, asparagus, carrot, celery, and grain, pulse, and fruits of all kinds, are not to be esteemed as permanent, because all of them, if left to themselves in a poor soil, would degenerate, and resume the qualities they have in a wild state. The soil has some effect also upon leaves; for, though it is less common for the leaves to differ on the same plant, as they do in some species of dittander, dwarf sun-flower, and Syrian mallow; yet it is observed, that *watery* soils are apt to produce a division in the lower leaves of the plant, and even to render capillary such as are produced under the water; as in water crow-foot, and water-cress; and also
in

in water-hemlock, water-parsnip, water drop-wort, &c. And, on the contrary, that *mountainous* plants usually have their upper leaves more divided, and their lower ones more entire; as in burnet-saxifrage, coriander, &c.

Both leaves and flowers are also subject to other variations, the causes of which are hitherto unascertained. The leaves of the polygonum amphibium, or amphibious snakeweed, in *wet* situations, are smooth: but, in *dry* and warm situations, rough. Some authors, therefore, have reckoned them as distinct species; but, let them change situations, and the appearances will be changed likewise. But why the leaves of mint are sometimes curled, those of holly or mezereon variegated with white, &c. is a more difficult matter to determine; seeing that slips from these plants, though transplanted into different soils, do not lose their peculiarities: but young ones raised from seeds return to their original form. It is evident, therefore, that these, however different in appearance, are not to be considered as distinct species, but only as varieties.

Varieties may generally be explained and reduced under their proper species with much ease, by comparing the variable marks of the variety with the natural plant: but there are a few which are attended with difficulty, and require judgment and experience; as in some species of hellebore, gentian, fumitory, valerian, caterpillar, and medic. In respect to the fumitory in question, it is known to be one species only, by the minuteness of its perianthium, the scale of its bud, the structure of its leaves, the situation of the branch, the place of the bractæ, the corolla, pod, seeds, and stigma; but it *varies* in the division of its bractæ, and in the root being more or less hollow. And that the valerians here spoken of are all of the same species, though they differ so greatly in the fruit, and often in having their leaves more jagged, is proved
from

from their dichotomous stems and annual roots, and from the structure of their leaves, corollæ, and seeds. Nor should the species of caterpillar and medic here instanced be either of them parted, although there is so remarkable a diversity in the fruit of the individuals. In the medic in particular, the forms of the snails, which nature has imitated in these plants, are scarcely less diversified than is the fruit of this mimic species; so that the botanist, who is studious of varieties, would hardly find any end to his labour of pursuing nature through the various shapes which she has so wantonly adopted.

ILLUSTRATION OF THE CLASSES, ORDERS, AND GENERA.

THE reader will by this time, it is presumed, have acquired a tolerable idea of the constitution of classes and orders, and of the mode in which the genera, species, and varieties, of plants, are to be distinguished and ascertained. Our next step will therefore be, to enumerate the genera of plants, by placing them under their proper classes and orders, agreeably to the Linnæan system; and, for the better instruction of the young botanist, we shall select a subject out of each of the twenty-four classes, by way of examples for investigation; each of which we shall systematically describe, and delineate by correct figures in the Engravings.

CLASS I. MONANDRIA.

The flowers arranged under this class contain only one stamen, and either one, or at most two, pistilla; It might therefore be expected, from the simplicity of their structure, that all the flowers of this class would be very easy to investigate; and so they undoubtedly would, were it not for the extreme minuteness of their parts. But, as the flowers in several of the genera are sufficiently conspicuous, the first of which

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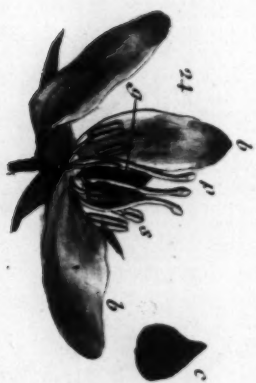
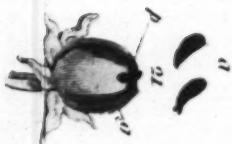
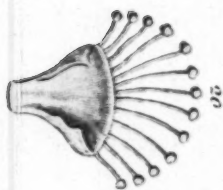
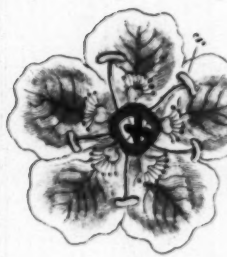
We have instanced in Plate X. fig. 1. the inexperienced botanist will of course investigate these, before he attempts the others, which require longer practice, and more accurate observation. But indeed the difficulty attending the examination of even the *minuteſt* flowers, might easily be overcome by the assistance of a botanical microscope. There is a sort recommended by Dr. Withering, very ingenious, and very cheap. The expence would be repaid in a thousand different ways, by the gratification and pleasure it affords in the dissection of flowers, by exposing the beautiful fabric of the minuteſt parts of the fructification. A great many of our delineations in the following examples could not have been accomplished without the aid of the microscope.—The genera belonging to this class are divided into two orders, viz.

Order 1. MONOGYNIA, or such plants as have but one pistillum. Of these there are thirteen genera, distinguished into, 1. Trilocular, such as have the pericarpium divided into three loculaments: of which there are eleven, viz. Canna, Indian flowering-reed; Amomum, ginger; Costus; Alpinia; Maranta, Indian arrow-root; Curcuma, turmeric; Kæmpferia; Thalia; Myrosma; and Renealmia. 2. Monospermous, such as have a single seed: of which there are three; viz. Boerhavia, hog-weed; Salicornia, jointed glass-wort; and Hippuris, mare's-tail.

Order 2. DIGYNIA, comprehending such plants as have two pistilla. This order contains five genera, viz. Corispermum, tick-seed; Callitriche, star-headed water chickweed; Blitum, strawberry-blite; Cinna; and Mnium. The genus Cinna, in this order, being found to vary with one, two, and *three*, stamens, has given occasion to its being lately associated with the Agrostides, in the class Triandria.

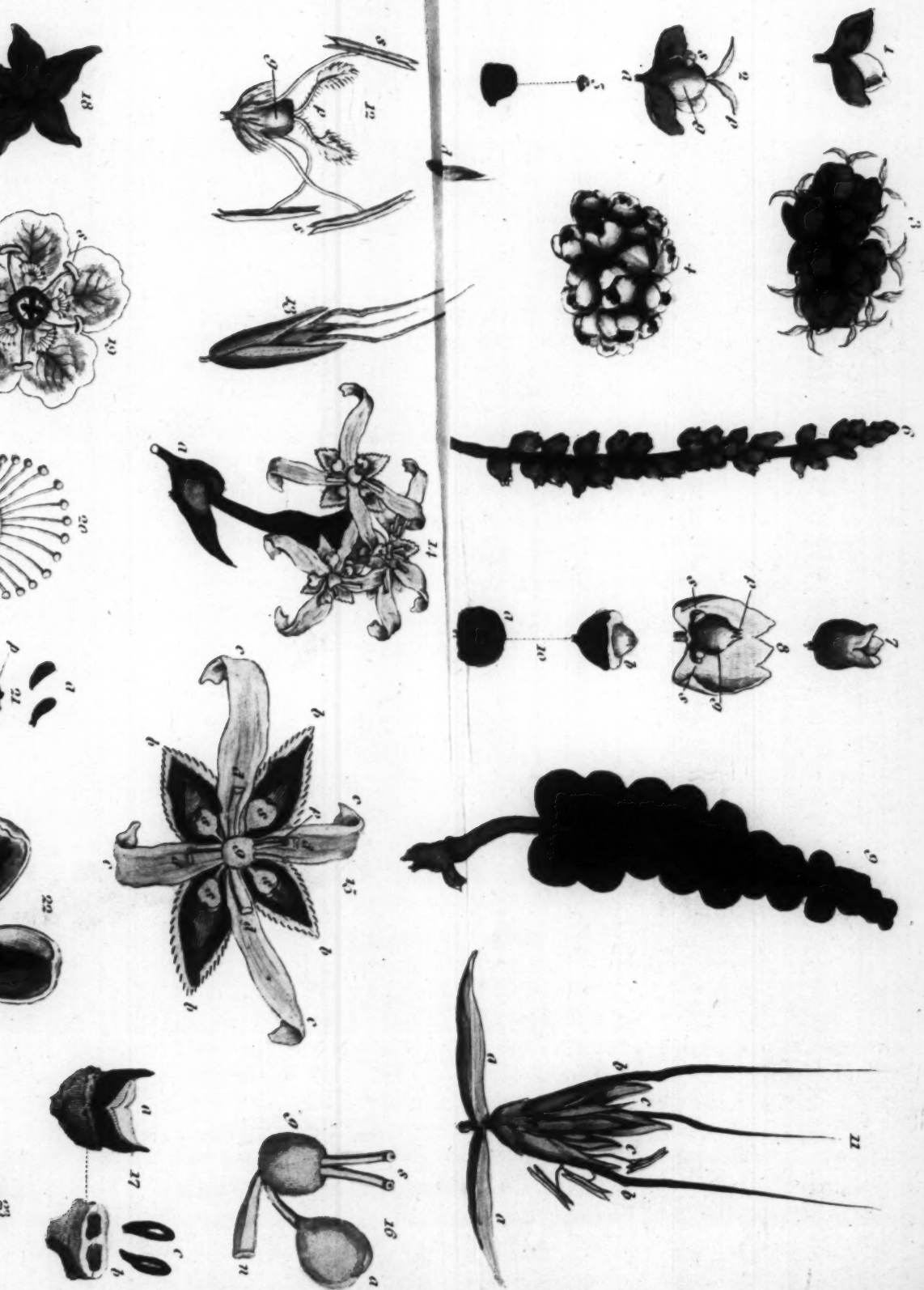
It seems necessary in this place, for the purposes of instruction, to give some general outline, whereby

the young botanist may be guided in first attempting the investigation of plants. Accordingly, when a flower is chosen for examination, the first thing to be determined is the class to which it belongs. This is to be done by ascertaining the number of its stamens, according to the preceding Table of Classes. Should there be a difficulty in ascertaining the number of the stamens, on account of the number appearing different in different flowers, though belonging to the same plant, it is advisable to examine one or more of the flowers which are yet unopened, for the antheræ are in that state more distinct, and we may be certain that none of them have been lost. It is best not to trust to the examination of one flower only; for we shall sometimes find the number of stamens to be really different, in different flowers, upon the same plant; but in that case the classic character must be taken from the *primary* or terminating flower, as before directed. Having determined the class, we are next to see how many orders the class consists of; and, after observing the circumstances of the pistillum, or other characters by which the orders are determined, we must compare these with the plant before us, and we shall readily discover the class and order to which it systematically belongs. Doubtful matters may sometimes arise; but these will soon be made clear by a little practice, and attentive observation. In consulting the generic descriptions, the learner should pay particular attention to the structure of the pistillum, and particularly to that of its germen, when it begins to ripen into a pericarpium; because, these parts being most essential to the continuation of the species, they are less liable to variation than the other less important parts. The young student ought to practise the investigation of genera only, for some time, before he attempts to ascertain a species; and when by this means he has acquired a pretty accurate knowledge



Genera of Plants. Vol. 1.

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knowledge of classes and orders; also of the parts composing a flower, and its subsequent state of fruit, or fructification, and likewise of the terms employed in describing them; he may next proceed to the discrimination of *species* and *varieties*.

EXAMPLE FOR INVESTIGATION.

Let it be required to describe systematically the genus *Blitum*, or strawberry-blite, from the second order of the above class. The parts of fructification are very minute, they are therefore magnified, to show them distinctly. The young botanist having collected the fructification from the plant in its *early*, and *mature*, state, he is to dissect the parts, and lay them down in the following manner. Calyx: a perianthium tripartite, patent, permanent; see Botanical Plate XI. fig. 1. the segments ovate, equal; two of them having a wider opening between them, as at *a*, fig. 2. where the stamen is placed; growing in clusters, as at fig. 3. COROLLA, none. Stamen: the filament setaceous, longer than the calyx, within the middle division, erect: the antheræ twin, or double, as at *s*, fig. 2. PISTILLUM: the germen ovate, as at *g*, acuminate; styles two, erect, spreading asunder; stigmas simple. PERICARPIUM: a capsule, fig. 4. very thin, or rather the shell of the seed; ovate, a little compressed, lodged within the calyx, which now assumes the appearance of a berry, and all the cluster resembling a wood-strawberry. SEED: single, globular, compressed, the size of the capsule, as at fig. 5.

CLASS II. DIANDRIA.

The flowers of this class contain two stamina only; and the fructification, being simple and obvious, presents no difficulty to the learner. The genera are arranged under three orders, the blossoms having either one, two, or three, pistilla.

Order 1. **MONOGYNIA**, comprehending such plants as have but one pistillum. This order contains thirty-three genera, distinguished into, 1. Such as have regular corollæ, of which there are eleven, viz. *Nyctanthes*, Arabian jessamine; *Jasminum*, jessamine; *Ligustrum*, privet; *Phillyrea*, mock-privet; *Olea*, olive; *Chionanthus*, snowdrop-tree, or fringe-tree; *Syringa*, lilac; *Dialium*; *Eranthemum*; *Circæa*, enchanters' nightshade; and *Wulsenia*. 2. Such as have irregular corollæ, and the fruit angiospermous, of which there are ten, viz. *Veronica*, speedwell; *Pæderota*; *Justicia*, Malabar nut; *Dianthera*; *Gratiola*, hedge-hyssop; *Schwenkia*; *Pinguicula*, butterwort; *Utricularia*, water-milfoil; *Calceolaria*; and *Globba*. 3. Such as have irregular corollæ, and the fruit gymnospermous; of which there are twelve, viz. *Verbena*, vervain; *Lycopus*, water horehound; *Amethystia*; *Gunila*; *Ziziphora*, Syrian field basil; *Monarda*, Oswego tea; *Rosmarinus*, rosemary; *Salvia*, sage; *Collinsonia*; *Morina*; *Ancistrum*; and *Thouinia*.

Order 2. **DIGYNIA**, comprehending such plants as have two pistilla. This order contains but one genus, viz. *Anthoxanthum*, vernal grass.

Order 3. **TRIGYNIA**, comprehending such plants as have three pistilla. There is but one genus of this order, viz. *Piper*, pepper.

EXAMPLE FOR INVESTIGATION.

We take from the third order of this class the plant *Piper*, or common black pepper; which, having its fructification very different from any of those we have before delineated, seems the best calculated for examination in this place. Its parts are as follow: **CALYX**, Plate XI. fig. 6. an imperfect spatha; the spadix filiform, very simple, covered with flowers; the perianthium, or cup, magnified at fig. 7. monophyllous, narrowing at each end, and swelling in the middle;

middle; the mouth dentate, having three teeth, deciduous. COROLLA: none, unless the calyx be taken for a corolla. STAMINA, *s*, fig. 8; filaments none; the antheræ two, opposite, placed at the root of the germen, subrotund. PISTILLUM, *p*, fig. 8; the germen, *g*, large, ovate; styles none; stigmas three, setaceous, or bristle-shaped, rising out of the germen, at *p*. PERICARPIUM: a berry, carnos, subrotund, unilocular, many on a spike, growing with very minute peduncles, as at fig. 9. which shows the branch fig. 6. in its matured or ripened state. SEED, fig. 10. solitary, subglobous, wrinkled, surrounded with an arillus; as shown at *a*, magnified; *b*, a transverse section of the pericarpium, to show the single seed.

CLASS III. TRIANDRIA.

The plants in this class consist of those only whose flowers are furnished with three stamina; and it comprehends the greater part of the grasses, besides some other vegetables nearly allied to them. And, although the flowers in these are generally disregarded, they will not, to an attentive observer, appear less curiously constructed, than those which boast of gayer colours and more conspicuous parts. The solicitude of Providence for the preservation of grasses, is evident from this; that the more the leaves are consumed, the more the roots increase. The great Author of Nature designed, that the delightful verdure of these plants should cover the surface of the earth, and that they should afford nourishment to an almost infinite number of his creatures. But what increases our admiration most is, that, although the grasses constitute the principal food of herbivorous animals, yet, whilst they are left at liberty in the pasture, they leave untouched the straws which support the flowers, that the seeds may ripen and sow themselves. Add to this, that many of the seemingly dry and dead leaves of grasses revive, and renew their verdure in the spring.

And

And on lofty mountains, where the summer heats are hardly sufficient to ripen the seeds, the most common grasses are those which are viviparous, and consequently propagate themselves without seeds. No part of botany, perhaps, at first sight, appears more difficult than the study of grasses; but, the method of accurate dissection and observation once adopted, no part is more certain or more easy. To gain a clear idea of the structure of the flowers, they must be examined just before the antheræ discharge their pollen; and by comparing them in that state with the example given in the plate, and with the generic description, the principal difficulties will soon be surmounted. The botanic microscope will be found extremely useful in dissecting the minuter parts of grasses. The plants in this class are arranged under three orders, viz.

Order 1. MONOGYNIA, comprehending such plants as have but one pistillum. This order contains thirty-four genera, distinguished into, 1. Those whose flowers have no spatha or amentum; of which there are sixteen, viz. Valeriana, valerian; Olax; Willichia; Tamarindus, tamarind-tree; Rumpfia; Cnecorum, widow-wail; Camocladia, maiden plum; Melothria, small creeping cucumber; Ortega; Læflingia; Polycnemum; Hippocratea; Rotala; Witsenia; Pomereulla; and Dilatris. 2. Such as have spathaceous flowers, and a trilocular capsule; of which there are ten, viz. Crocus, saffron; Ixia; Gladiolus, corn-flag; Antholyza; Iris, flower-de-luce; Moræa; Wachendorfia; Commelina, day-flower; Callisia; and Xyris. 3. Such as have an imbricated amentum, and are gymnospermous; of which there are eight, viz. Schænus, bastard cypress; Cyperus, greater galangale; Scirpus, rush-grass; Eriophorum, cotton-grass; Lygeum, hooded matweed; Nardus, mat-grass; Kyllinga; and Fuirena.

Order 2. DIGYNIA, comprehending such plants as have

have two pistilla. This order contains thirty-one genera, viz. Bobarta; Cornucopia, horn-of-plenty grass; Saccharum, sugar-cane, Panicum, panic-grass; Phleum, cat's-tail grass; Alopecurus, fox-tail grass; Milium, millet; Agrostis, bent-grass; Aira, hair-grass; Melica, melic, or rope-grass; Poa, meadow-grass; Briza, quaking-grass, Uniola, sea-side oats of Carolina; Dactylis, cock's-foot grass; Cynosurus, dog's-tail grass; Festuca, fescue-grass; Bromus, brome-grass; Stipa, feather-grass; Avena, oats; Lagurus, hare's-tail grass; Arundo, reed; Aristida, oat-grass; Lolium, darnel, or rye-grass; Elymus, lyme-grass; Secale, rye; Hordeum, barley; Triticum, wheat; Phalaris, canary-grass; Paspalum, Rott-hoella, sea-hard grass; and Anthistiria.

Order 3. TRIGYNIA, comprehending such plants as have three pistilla. This order contains eleven genera, viz. Eriocaulon, net-work; Montia, small water chickweed; Proserpinaca; Triplaris; Holosteum; Polycarpon; Mollugo, African chickweed; Minuartia; Queria; Lechea; and Koenigia.

EXAMPLE FOR INVESTIGATION.

As a plant familiar to most people, and growing in every part of the kingdom, we have chosen out of the second order of this class, the Avena, or oat, as a proper subject to exemplify the fructification of grasses. The parts are as follow: CALYX, *a a*, fig. 11, magnified; a glume generally multiflorous, or many-flowered, bivalvular, wrapping up the flowers loosely together, valves lanceolate, acute, ventricose, loose, large, awnless. COROLLA, *b b*, bivalvular, the inferior valve harder than the calyx, of the same size, roundish, ventricose, acuminate at both ends, emitting from the back an arista or awn spirally twisted, and bending like a knee. NECTARIUM, *c c*, two-leaved; leaflets lanceolate, gibbous at the base. STAMINA, *s*, fig. 12; filaments three, capillary; anthe-

æ oblong, bifurcate. Pistillum, *p*; the germen, *g*; obtuse; styles two, reflex, pilous, in the upper part plumous; stigmas simple. PERICARPIUM, fig. 13; none but the corolla, which supplies its place, adhering close to the seed, which it involves without gaping. SEED, *d*; single, slender-oblong, acuminate at both ends, marked with a longitudinal furrow.

CLASS IV. TETRANDRIA.

This class consists of such plants as bear hermaphrodite flowers, furnished with four stamina. The flowers of this class may be known from those of the fourteenth by this distinction, that the stamina in these are of an equal length; whereas in those of the fourteenth, which have four stamina likewise, there are two long and two short. The orders of this class are three, viz.

Order 1. MONOGYNIA, comprehending such plants as have but one pistillum. This order contains seventy genera, distinguished into, 1. Such as have aggregate flowers properly so called, with the seeds single and naked; of which there are seven, viz. Protea, silver-tree; Cephalanthus, button-wood; Globularia, blue daisy; Dipsacus, teasel; Knautia; Scabiosa, scabious; and Allionia. 2. Such as have their flowers monopetalous on a double fruit, and the style bifid, of which there are twenty, viz. Hedyotis; Spermacoce, button-weed; Sherardia, little field-madder; Asperula, wood-roof; Diodia; Knoxia, Manettia; Houstonia; Galium, lady's bedstraw; Crucianella, petty madder; Rubia, madder; Scabita; Embotrium, Hydrophylax; Hartogia; Acæna, Banksia; Orica; Othra; and Skimmia. 3. Such as have monopetalous flowers otherways circumstanced; of which there are twenty, viz. Siphonanthus; Catesbæa, lily-thorn; Ixora, American jessamine; Pavetta; Petisia; Mitchellia; Callicarpa, John-sonia; Aquartia; Polypremum, Carolina flax; Penæa;

næa; Blaeria; Buddleja; Exacum; Plantago, plantain; Scoparia; Rhacoma; Centunculus, base pimpinell; Sanguisorba, greater wild burnet; Cissus; and Ægiphila.

4. Such as are tetrapetalous and complete, not wanting calyx or corolla; of which there are twelve, viz. Epimedium, barren-wort; Cornus, dog-wood, or cornelian cherry; Fagara; Tomex; Amannia; Ptelea, shrub trefoil; Ludwigia, base Virginian loosestrife; Oldenlandia; Isnardia; Santalum, saunders; Trapa, floating water caltrops; and Samara. 5. Such as are incomplete, calyx or corolla wanting; of which there are eleven, viz. Dorstenia, contrayerva; Elæagnus, wild olive; Krameria; Rivinia; Salvadora; Camphorosma; Alchemilla, lady's mantle; Struthiola; Cometes; and Sirium.

Order 2. DIGYNIA, comprehending such plants as have two pistilla. This order contains nine genera, viz. Alphanes, parsley-piert; Cruzitta; Buffonia, toad-grass; Hamamelis, witch-hazel; Cuscuta, dodder; Hypecoum; Galopina; Gomozia; and Gonocarpus.

Order 3. TETRAGYNIA, comprehending such plants as have four pistilla. This order contains seven genera, viz. Ilex, holly; Coldenia; Potamogeton, pond-weed; Ruppia, sea or tassel grass; Sagina, pearl-wort; Myginda; and Tillæa, small annual houseleek.

EXAMPLES FOR INVESTIGATION.

We have selected from the second order of this class the plant Hamamelis, or witch-hazel; which, from its curious fabric, will afford a very pleasing delineation of its parts. CALYX: an involucreum; Plate XI. fig. 14, a; triphyllous, or three-leaved, triflorous, supporting a cluster of three flowers; the two inferior leaflets subrotund, small, blunt; the outermost larger, lanceolate. Perianthium double;

the exterior diphyllous, small, subrotund; the interior tetraphyllous, erect, oblong, acute, equal, ciliated on the margin: this inner perianthium is shown at *b*, fig. 15, considerably magnified. **COROLLA**: petals four, marked *c*; linear, equal, very long, obtuse, reflexed at the apex. **NECTARIUM**: four folioles, or truncate leaflets, growing on the petals of the corolla, marked *d*. **STAMINA**, marked *e*; filaments four, linear, shorter than the calyx; antheræ obovate, two-horned, bent in. **PISTILLUM** marked *f*; the germen ovate, villose; styles two, same length with the stamina; stigmas capitate. Fig. 16, shows the parts taken out of the flower, and more considerably magnified; *g*, the germen, which becomes a nut; *h*, the nectary; *i*, the antheræ; *j*, the stigmas. **PERICARPIUM**, *a*, fig. 17; a nut, ovate, half covered with the calyx, obtuse, furrowed on both sides at the tip; having two little horns spreading horizontally, two-celled, two-valved; *b*, a transverse section of the nut; *c*, the seeds.

CLASS V. PENTANDRIA.

This class consists of such plants as bear hermaphrodite flowers, furnished with five stamina; and they are divided into six orders. The first order includes the plants with rough leaves; which, Linnæus says, are mucilaginous, and esculent. As there is no seed-vessel, the cup does not fall off, but remains after the blossom decays, and contains the seeds. Those plants in this order which bear berries, and have a blossom composed of one petal, are generally poisonous. The second order contains the plants whose flowers are disposed in umbels or rundles. These are divided into such as have both a general and a partial involucre, such as have only a partial one, and such as have none at all; but as the involucra are not very constant, and in some species are apt to fall off; and as the blossoms, stamen, and pistilla,

pistilla, are so much alike as to afford but little assistance in the determination of the genera and species, the student should pay particular attention to the seeds, which furnish the most unequivocal generic characters, and often come powerfully in aid of the specific character. On this account, it may be advisable to gather some specimens in which the seeds are nearly ripe, and others but just opening into flower. The umbelliferous plants, in dry situations, are aromatic and carminative; in moist ones, acrid, and sometimes poisonous. The greatest virtues are contained in the seeds and roots. Many of them are eaten at our tables, as the roots of carrot and parsnip, and the leaves of celery. The seeds of coriander and caraway are used in confectionary.

Order 1. *MONOGYNIA*, comprehending such plants as have but one pistillum. There are one hundred and fifty-four genera; distinguished into, 1. *Monopetalous tetraspermous*, or four-seeded, of which there are sixteen, viz. *Heliotropium*, turnsole; *Myosotis*, mouse-ear scorpion-grass; *Lithospermum*, gromwell; *Anchusa*, bugloss; *Cynoglossum*, hound's-tongue; *Pulmonaria*, lung-wort; *Symphytum*, comfrey; *Onosma*; *Cerinthe*, honey-wort; *Borago*, borage; *Asperugo*, wild bugloss, or goose-grass; *Lycopsis*; *Echium*, viper's bugloss; *Nolana*; *Tournefortia*, basket-withe; and *Messerschmidia*. 2. *Monopetalous*, with the capsule *within* the flower; of which there are thirty-five, viz. *Diapensia*; *Arctia*; *Androsace*; *Primula*, primrose; *Cortusa*, bear's-ear sanicle; *Porana*; *Soldanella*, soldanel; *Dodecatheon*, Virginian cowslip; *Cyclamen*, sow-bread; *Menyanthes*, hog-bean, or marsh-trefoil; *Hottonia*, water milfoil, or water violet; *Hydrophyllum*, water leaf; *Lysimachia*, loosestrife; *Anagallis*, pimpernel; *Theophrasta*; *Patagonula*; *Spigelia*, worm-grass; *Ophiorrhiza*, serpent's tongue; *Randia*; *Azalea*, American upright honeysuckle; *Plumbago*, lead-wort;

Phlox, lichnidea, or base lychnis; Convolvulus; bindweed; Ipomea, quamoclit; Lisianthus; Brossæa; Allamanda; Polemonium, Greek valerian; Nigrina; Retzia; Epacris; Doraena; Weigela; Tectona, Indian oak, or teek-wood; and Ignatia, St. Ignatius's beans. 3. Monopetalous, with the germen *below* the flower; of which there are thirty-one, viz. Campanula, bell-flower; Roella; Phyteuma, rampions; Trachelium, umbelliferous throat-wort; Samulus, round-leaved water pimpernel; Nauclea; Rondeletia; Macrocnemum; Bellonia; Portlandia; Cinchona, jesuits' bark tree; Psychotria; ipecacuanha; Coffea, coffee-tree; Chiococca, snow-berry; Ceropegia; Lonicera, honeysuckle; Trioestum, fever-root, or false ipecacuanha; Morinda; Conocarpus, button-tree; Hamellia; Erithalis; Menais; Genipa; Matthiola; Scævola; Mussænda; Virecta; Escalonia; Caroxylon; Elæadendrum; and Hovenia. 4. Such as have declining stamina; of which there are seven, viz. Mirabilis, marvel of Peru; Coris, heath low pine; Verbascum, mullein; Datura, thorn-apple; Hyocyamus, henbane; Nicotiana, tobacco; and Atropa, deadly nightshade. 5. Monopetalous, with a berry above the receptacle; of which there are twenty-two, viz. Physalis, alkekengi, or winter cherry; Solanum, nightshade; Capsicum, Guinea pepper; Strychnos, poison-nut; Jacquinia; Chironia; Cordia, Sebesten plum; Pergularia; Cestrum, bastard jessamine; Ehretia, base cherry-tree; Varonia; Laugieria; Lycium, box-thorn; Chrysophyllum, star-apple; Sideroxylum, iron-wood; Rhamnus, buckthorn; Arduina, Cape buckthorn; Ellisia; Phylica, base-alaternus; Bladhia; and Fagraea. 6. Polypetalous, of which there are thirty-one, viz. Ceanothus, New Jersey tea; Byttneria; Myrsine, African box-tree; Celestrus, staff-tree; Euonymus, spindle-tree; Diosma, African spiræa; Brunia; Itea; Galax; Cedrela, Barbadoes base cedar;

cedar; *Mangifera*, mango-tree; *Hirtella*; *Ribes*, currant and gooseberry-tree; *Gronovia*; *Hedera*, ivy; *Vitis*, vine; *Lagœcia*, wild cumin; *Sauvagesia*; *Claytonia*; *Achyranthes*; *Roridula*; *Kuhnia*; *Plectronia*; *Cyrilla*; *Aquilicia*; *Heliconia*, base or wild plantain; *Carissa*; *Celofia*, cock's-comb; *Calodendrum*; *Chenolea*; and *Corynocarpus*. 7. Incomplete flowers, or having no petals, of which there are three, viz. *Illecebrum*, mountain knot-grass; *Glaux*, sea milk-wort, or black salt-wort; and *Thesium*, base toad-flax. 8. Such as have the lobes of the corollæ bent obliquely to the right; of which there are nine, viz. *Rauwolfia*; *Cerbera*; *Vinea*, periwinkle; *Gardenia*, Cape jessamine; *Nerium*, oleander, or rosebay; *Plumeria*, red jessamine; *Echites*, Savanna flower; *Cameraria*; and *Tabermontana*. The genus *Matthiola*, in this order, is now supposed to be only a species of *Guettarda*, and is therefore placed, by the later botanists, in the class *Hexandria*.

Order 2. *DIGYNIA*, comprehending such plants as have two pistilla. This order contains seventy-five genera, distinguished into, 1. Such as have the lobes of the corollæ bent obliquely to the right; of which there are six, viz. *Periploca*, Virginian silk; *Cynanchum*, base dog's-bane; *Apocynum*, dog's-bane; *Asclepias*, swallow-wort; *Dinconia*; and *Stapelia*, African swallow-wort. 2. Monospermous, or single-seeded; of which there are ten, viz. *Herniaria*, rupture-wort; *Chenopodium*, goose-foot, or wild orache; *Beta*, beet; *Salsola*, glass-wort; *Anabasis*, berry-bearing glass-wort; *Cressa*; *Gomphrena*, globe-amaranth; *Steris*; *Bosea*; yerva-mora, or golden-rod tree; and *Ulmus*, elm-tree. 3. Polyspermous, or many-seeded; of which there are thirteen, viz. *Nama*; *Hydrolea*; *Heuchera*, Virginian fanicle; *Swertia*, marsh gentian; *Schrebera*; *Velezia*; *Gentiana*, gentian, or fell-wort; *Bumalda*; *Coprosma*; *Cussonia*; *Melodinus*; *Russelia*; and *Vahlia*.

Vahlia. 4. *Gymnodispermous*, having two naked seeds, with a simple umbel; of which there are three, viz. *Phyllis*, base hare's-ear; *Eryngium*, eryngo, or sea-holly; and *Hydrocotyla*, water navel-wort. 5. *Gymnodispermous* with an universal and partial involucre, of which there are twenty-seven, viz. *Sanicula*, sanicle; *Astrantia*, black master-wort; *Bupleurum*, hare's-ear; *Echinophora*, prickly parsnep; *Tortilium*, hart-wort of Crete; *Caucalis*, base parsley; *Arteria*; *Daucus*, carrot; *Ammi*, bishop's weed; *Bunium*, pig-nut, or earth-nut; *Conium*, hemlock; *Selinum*, milk parsley; *Athamanta*, base spig-nel; *Peucedanum*, hog's-fennel, or sulphur-wort; *Crithmum*, samphire; *Hasselquistia*; *Cachrys*; *Ferula*, fennel-giant; *Laserpitium*, laser-wort; *Hera-cleum*, cow-parsnip; *Ligusticum*, lovage; *Angelica*; *Sium*, water-parsnip; *Sison*, base stone-parsley; *Bubon*, Macedonian parsley; *Cuminum*, cumin; and *Oenanthe*, water drop-wort. 6. *Gymnodispermous* with only one partial umbel; of which there are eight, viz. *Rhelandrium*; *Cicuta*, water hemlock; *Aethusa*, lesser hemlock, or fool's parsley; *Coriandrum*, coriander; *Scandix*, shepherd's needle, or Venus's comb; *Cherophyllum*, wild chervil; *Imperatoria*, master-wort; and *Seseli*, hart-wort of Marceilles. 7. *Gymnodispermous* without any involucre; of which there are eight, viz. *Thapsia*, deadly carrot, or scorching fennel; *Pastinaca*, parsnip; *Smyrniolum*, alexanders; *Anethum*, dill; *Carum*, or caraway; *Pimpinella*, burner saxifrage; *Apium*, parsley; and *Egopodium*, herb gerard, gout-wort, or wild angelica.

Order 3. *TRIANDRA*, comprehending such plants as have three pistilla. This order contains seventeen genera, viz. *Rhus*, sumach, or poison-tree; *Viburnum*, plant mealy-tree, or wayfaring-tree; *Cassine*, Hottentot cherry; *Sambucus*, elder-tree; *Spathelia*; *Staphylea*, bladder-nut; *Tamarix*, tamarisk; *Turnera*;

nera ; Telephium, tree-orpine ; Corrigiola, base knot-grass ; Pharnaceum ; Alline, chickweed ; Drypis ; Baselia, Malabar nightshade ; Sarothra, base gentian ; Xylophylla, love-flower ; and Semecarpus.

Order 4. TETRAGYNIA, comprehending such plants as have four pistilla. This order contains two genera, viz. Parnassia, grass of Parnassus ; and Evolvulus.

Order 5. PENTAGYNIA, comprehending such plants as have five pistilla. This order contains ten genera, viz. Aralia, berry-bearing angelica ; Mahernia ; Staice, thrift, or sea-pink ; Linum, flax ; Aldrovanda ; Drosera, sundew ; Crassula, lesser orpine ; Sibbaldia ; Gisekia ; and Commerfonia.

Order 6. POLYGYNIA, comprehending such plants as have many pistilla. This order contains but one genus, viz. Myosurus, mouse-tail.

EXAMPLE FOR INVESTIGATION.

To illustrate the class Pentandria, we shall select from the fourth order the plant Parnassia, or grass of Parnassus ; which, in this place, will come very properly under examination. **CALYX**, fig. 18 ; a perianthium quinquepartite ; the laciniae oblong, acute, patent, permanent. **COROLLA**, fig. 19 ; the petals five, subrotund, emarginate, striate, concave, patent. **NECTARIUM** : divided into five distinct parts, placed on the base of the petals ; each part consisting of a cordate squama, concave, with thirteen filiform styles, furnished with globular heads, rising gradually higher to the centre, forming a semicircular curve : one of these nectaria, taken out of the corolla, is shown considerably magnified, at fig. 20 ; it is the *essential* character of the genus. **STAMINA**, 5, fig. 19 ; filaments five, subulate, length of the corolla ; antherae depressed, incumbent. **PISTILLUM**, fig. 21 ; germen, 5, ovate, bluntly four-cornered, large ; styles, none ; stigmas, four, obtuse, permanent, lying on the apex of

of the germen, crosswise, coloured. PERICARPIUM? the germen, fig. 21; now a capsule, tetragonous, unilocular, opening with four valves, fig. 22; united with the receptacle, to which the seeds adhere. SEEDS: a great many, oblong, lying upon the receptacle, attached to the valves of the capsule; *a*, two seeds magnified.

CLASS VI. HEXANDRIA.

In this class the flowers contain six stamina, *all of the same length*; whereas, in the Tetradynamia class, the stamina, though six in number, are *unequal in length*, four of them being long, and two of them short: but, as the difference in their length is not always very obvious, it may be further observed, as a mark of distinction, that in this class *none* of the flowers have four petals, which is the case with *all* those in the class Tetradynamia. Some of the bulbous roots in this class are found to be noxious; as those of the narcissus, hyacinth, and crown imperial; others are corrosive, as the garlic or onion tribe; but by roasting or boiling they lose great part of their acrimony. The genera in this class are divided into the five orders following.

Order 1. MONOCYNEA, comprehending such plants as have but one pistillum. This order contains sixty-two genera, distinguished into, 1. Such as have trifid corollæ, and a calyx; of which there are seven, viz. Bromelia, ananas, or pine-apple; Tillandsia; Burmannia; Tradescantia; Virginian spider-wort; Bursera; Jamaica birch-tree; Licuala; and Lachemalia. 2. Such as have monophyllous spathæ, of which there are nine, viz. Pontederia; Hæmanthus, blood-flower; Galanthus, snowdrop; Leucoium, greater snowdrop; Tolbagia; Narcissus, daffodil; Pancratium, sea-daffodil; Duroia; and Nandina. 3. Such as are hexapetalous and naked, i. e. without a calyx; of which there are twenty-five, viz. Crinum, alphodel-

asphodel-lily ; Amaryllis, lily-daffodil ; Bulbocodium ; Aphyllanthes ; Allium, garlic ; Lilium, lily ; Fritillaria, crown imperial ; Uvularia ; Gloriosa, superb lily ; Tulipa, tulip ; Erythronium, dog's-tooth violet ; Albuca, base star of Bethlehem ; Ornithogalum, star of Bethlehem ; Scilla, squill ; Hypoxis, base star-flower ; Cyanella ; Asphodelus, asphodel, or king's-spear ; Anthericum, spider-wort ; Leontice, lion's-leaf ; Dracena, dragon tree ; Asparagus, sparagrass, or speerage ; Ehrharta ; Massonia ; Phormium ; and Polia. 4. Monopetalous and naked, of which there are ten, viz. Convallaria, lily of the valley ; Polyanthes, tuberoze ; Hyacinthus, hyacinth ; Aletis, base aloe ; Yucca, Adam's needle ; Aloe ; Agave, American aloe ; Alstroemeria ; Capura ; and Hemerocallis, day-lily, or lily-asphodel. 5. Such as have a calyx, but the corollæ not trifid, of which there are thirteen, viz. Acorus, sweet rush ; Orontium, floating arum ; Calamus ; Juncus, rush ; Achras, sapota ; Richardia ; Prinos, winter-berry ; Berberis, barberry, or pipperidge-bush ; Loranthus ; Frankenia, sea-heath ; Hillia ; Peplis, water-purslane ; and Canarina, Canary bell-flower.

Order 2. DIGYNIA, comprehending such plants as have two pistilla. This order contains four genera, viz. Atraphaxis ; Oryza, rice ; Falkia ; and Gahnia.

Order 3. TRIGYNIA, comprehending such plants as have three pistilla. This order contains ten genera, viz. Flagellaria ; Rumex, dock ; Scheuchzeria, lesser flowering-rush ; Triglochin, arrow-headed grass ; Melanthium ; Medeola, climbing African asparagus ; Trillium, three-leaved nightshade ; Colchicum, meadow saffron ; Pelonias ; and Wurmbea.

Order 4. TETRAGYNIA, comprehending such plants as have four pistilla. Of this order there is but one genus, viz. Petivera, Guinea-hen weed.

Order 5. POLYGYNIA, comprehending such plants

as have many pistilla. Of this order there is but one genus, viz. *Alisma*, water-plantain.

EXAMPLE FOR INVESTIGATION.

We have chosen, from the third order of this class, a well-known familiar plant, the *Rumex*, or curled dock; being persuaded, that the more common and simple the subject of investigation is, the more every learner will have it in his power to make experiments for his own private information. In dissecting the fructification of this plant, the parts are necessarily magnified to a considerable degree, to make them distinct and obvious. They are as follow; **CALYX**, marked *a*, fig. 23; a perianthium triphyllous, the folioles or leaflets ovate, acute, coloured, reflected, permanent. **COROLLA**: the petals three, ovate or egg-shaped, not unlike the calyx, but larger, approaching, permanent: it is represented just as it begins to open, at *b*, fig. 23, sitting upon its calyx; and it is shown expanded at fig. 24. **STAMINA**, marked *s*; filaments five, capillary, very short; antheræ erect, didymous. **PISTILLUM**, marked *p*; germen, *g*, turbinate and triquetrous; styles three, capillary, reflected; stigmas large, lacinated. **PERICARPIMUM** none; the corolla approaching or closing up, and becoming three-cornered, as at fig. 25, contains the seed. **SEED**: single, triquetrous, or three-sided, marked *c*, magnified.

CLASS VII. HEPTANDRIA.

The plants of this class oppose no difficulty to the progress of the young botanist; they are all furnished with seven stamina; and are divided into four orders.

Order 1. MONOCYNIA, comprehending such plants as have but one pistillum. This order contains three genera, viz. *Trientalis*, winter green with chickweed

chickweed flowers; *Difandra*; and *Æsculus*, horse-chefnut.

Order 2. *DIGYNIA*, comprehending such plants as have two pistilla. This order contains but one genus, viz. *Limeum*.

Order 3. *TETRAGYNIA*, comprehending such plants as have four pistilla. Of this order there are but two genera, viz. *Saururus*, lizard's tail; and *Aponogeton*.

Order 4. *HEPTAGYNIA*, containing such plants as have seven pistilla. Of this order there is but one genus, viz. *Septas*.

EXAMPLE FOR INVESTIGATION.

In the third order of this class a plant occurs, whose fructification is an amentum, or catkin; it is the *Saururus*, or lizard's tail; and, as this kind of plant has not been before sufficiently illustrated, it comes now very properly under our notice. *CALYX*, fig. 26; an amentum, oblong, covered with very minute flowers; fig. 27, the same magnified to show the flowers more distinct; some of them pulled away. The proper perianthium marked *b*, fig. 28, monophyllous, ovate, lateral, coloured, pilous or hairy, permanent. *COROLLA*, none. *STAMINA*, *s*, fig. 28; filaments seven, filiform; antheræ oblong erect. *PISTILLUM*, *p*, fig. 28; the germens four, ovate, placed on the base of the proper perianthium, marked *g*; the styles thickish, subulate; the stigmas simple, acute, adhering within the apex of the germens: fig. 28, is taken from off the amentum, and very considerably magnified to expose these parts. *PERICARPium*: four berries, fig. 29, which were the four germens; ovate, unilocular; these berries adhere to the amentum till they ripen and fall away. *SEED*, *c*; single, ovate, the berries and seed greatly magnified.

CLASS VIII. OCTANDRIA.

This class consists of such plants as bear hermaphrodite flowers, furnished with eight stamina. The orders are four, viz.

Order 1. MONOGYNIA, comprehending such plants as have but one pistillum. Of this order there are thirty-one genera, viz. *Tropæolum*, Indian cress; *Osbeckia*, gold rose-feather; *Rhexia*, soap-wood; *Oenothera*, tree-primrose; *Gaura*, Virginian loosestrife; *Epilobium*, willow-herb, or French willow; *Mellicocca*; *Grislea*; *Amyris*, shrubby sweet-wood; *Allophyllus*; *Combretum*; *Fuchsia*; *Ximena*; *Mimusops*; *Jambolifera*; *Memecylon*; *Lawsonia*; *Vaccinium*, wortle-berry; *Erica*, heath; *Daphne*; *mezereon*, or spurge-laurel; *Dirca*, leather-wood; *Gnidia*; *Stellera*, German groundsel; *Passerina*, sparrow-wort; *Lachnæa*; *Antichorus*; *Chlora*, yellow centaury; *Dodonæa*; *Ophira*; *Guarea*; and *Bæckea*.

Order 2. DIGYNIA, comprehending such plants as have two pistilla. This order contains five genera, viz. *Galenia*, Cape jessamine; *Weinmannia*; *Moehringia*, mountain chickweed; *Schemiedelia*; and *Codia*.

Order 3. TRIGYNIA, comprehending such plants as have three pistilla. This order contains five genera, viz. *Polygonium*, knot-grass; *Coccoloba*, sea-side grape; *Paulinia*, supple-jack; *Cardiospermum*, heart-pea; and *Sapindus*, soap-berry.

Order 4. TETRAGYNIA, comprehending such plants as have four pistilla. This order contains four genera, viz. *Paris*, herb true-love, or one-berry; *Adoxa*, tuberous moschatel, or hollow-root; *Elatine*, water-wort; and *Haloragis*.

EXAMPLE FOR INVESTIGATION.

We have in this place selected the *Adoxa*, or tuberous

berous moschatel, belonging to the fourth order of this class. It is by some called *musk crowfoot*; the flowers having a strong smell of musk. CALYX, fig. 30: a perianthium, bifid, spreading flat, below the flowers, permanent. COROLLA: monopetalous, spreading, flat, quadrifid, the lacinias ovate, acute, longer than the calyx; many flowers in a cluster, fig. 31. STAMINA: the filaments eight, fig. 32, s; subulate, length of the calyx; antheræ subrotund. PISTILLUM, *p*; the germen within the receptacle of the corolla; styles four, simple, erect, length of the stamens, permanent; the stigmas simple: this figure is a blossom taken from the cluster, and greatly magnified. PERICARPIUM, fig. 33; a globous berry, situated between the calyx and corolla, the calyx joined at the base to the berry, umbilicate, quadrilobular. SEEDS; one in each cell, compressed; shown at *a*, magnified.

CLASS IX. ENNEANDRIA.

This class consists of such plants as bear hermaphrodite flowers, furnished with nine stamina. The orders are three, viz.

Order 1. MONOGYNIA, comprehending such plants as have but one pistillum. This order contains four genera, viz. *Laurus*, bay-tree; *Tinus*; *Anacardium*, acajou, or cashew-nut; and *Cassya*.

Order 2. TETRAGYNIA, comprehending such plants as have three pistilla. This order contains but one genus, viz. *Rheum*, rhubarb.

Order 3. HEXAGYNIA, comprehending such plants as have six pistilla. Of this order there is but one genus, viz. *Butomus*, flowering-rush.

EXAMPLE FOR INVESTIGATION.

The fructification of the plant which we shall now bring under inspection, is of a very singular and curious fabric; it is the *Cassya*, a native of both the Indies,

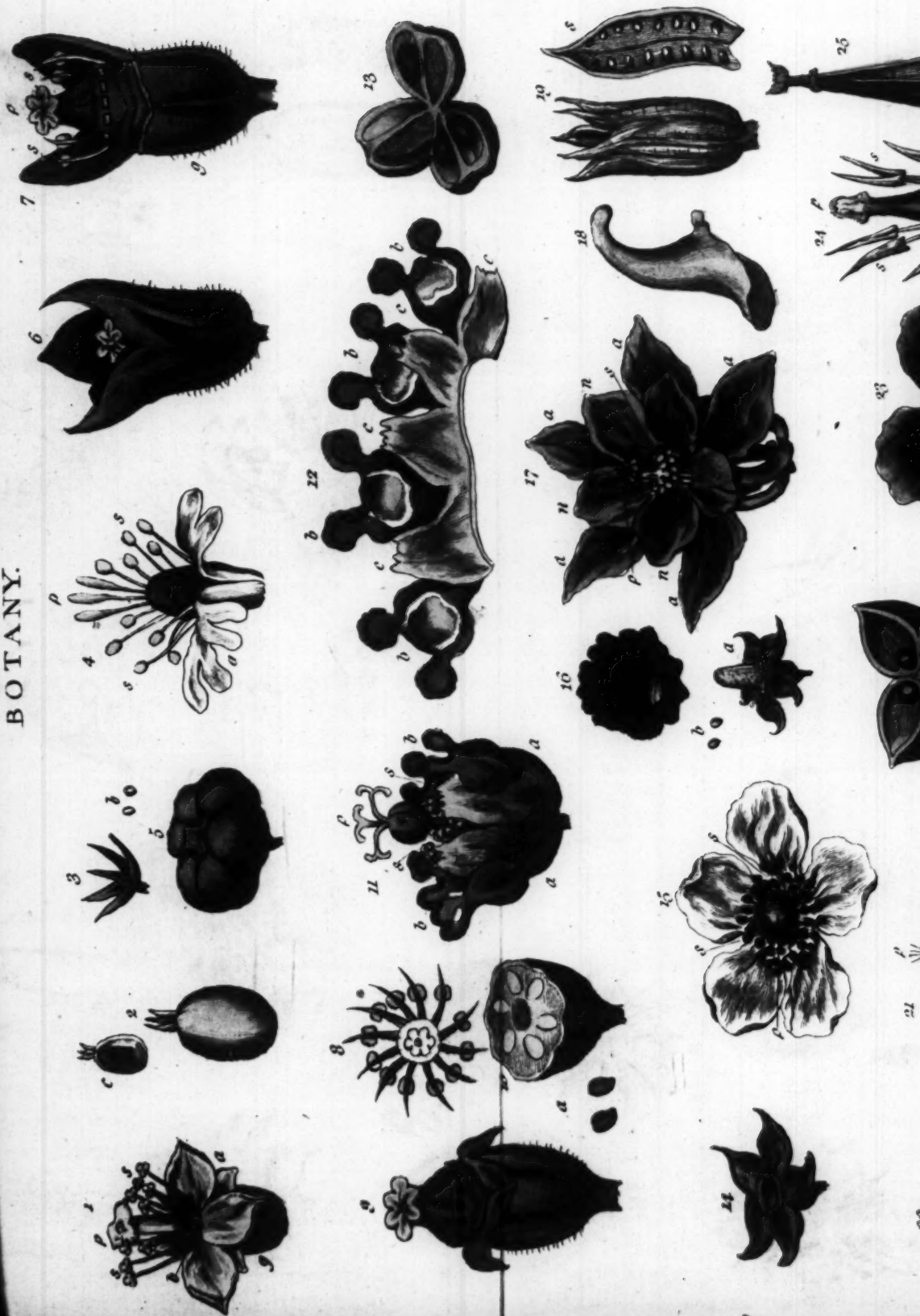
Indies, ranking in the first order of this class. **CALYX**, none; what was formerly taken for the calyx is now decided to be a part of the corolla. **COROLLA**, marked *a*, in the Botanical Plate XII. fig. 1, sexpartite: the three inferior petals, formerly taken for a calyx, very small, acute, concave; the three superior ones larger, subrotund, acute, concave, permanent, their margins from the middle to their apices convolute. **NECTARIUM**: formed of three glands marked *b*; oblong, truncate, coloured, of the length of the germen, and standing round it. **STAMINA**, marked *s*; the filaments nine, erect, subulate, flattish; the antheræ trilobate, or three-lobed. **PISTILLUM**, *p*; the germen *g*, inferior, standing under the flower, ovate; style cylindrical, thickish, length of the stamens; stigma obscurely trifid, obtuse. **PERICARPIMUM**, fig. 2; the receptacle, growing out into a depressed globular drupe, crowned with the converging corolla, perforated with a navel. **SEED**: a nut, globular, acuminate with the converging stamina; *c*, a section of the nut.

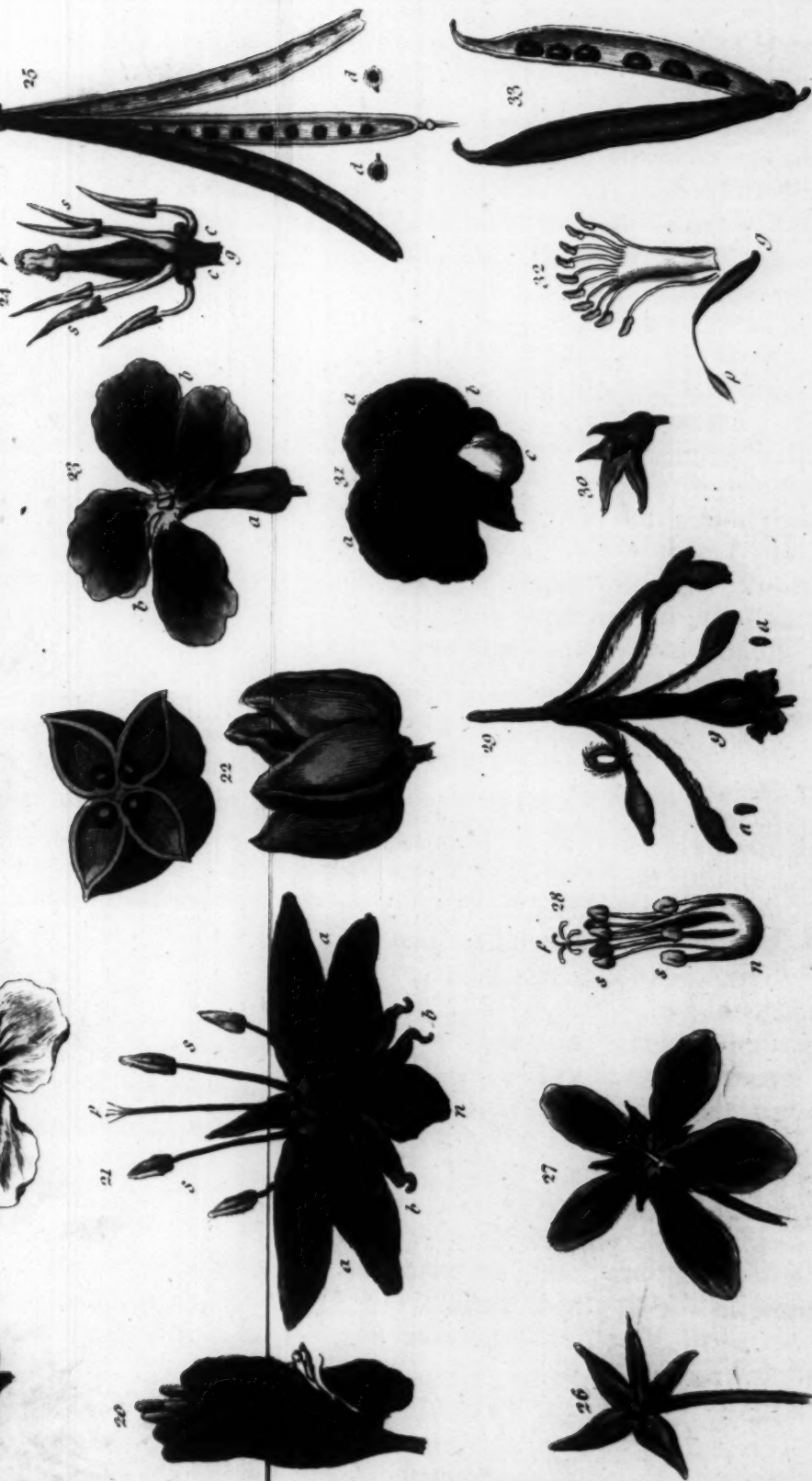
CLASS X. DECANDRIA.

In this class the flowers are likewise all hermaphrodite, and furnished with ten stamina each. The parts in general are pretty obvious to view, and may with ease be investigated by the young botanist. The genera are divided into the five following orders, viz.

Order 1. MONOGYNIA, comprehending such plants as have but one pistillum. This order contains fifty-six genera, distinguished into, 1. Such as have declined stamina, of which there are fourteen, viz. *Sophora*; *Anagyris*, stinking bean-trefoil; *Cercis*, Judas-tree; *Bauhinia*, mountain-ebony; *Parkinsonia*, Jerusalem thorn; *Hymenæa*, locust-tree, or courbaril; *Cassia*, wild fenna; *Poinciana*, Barbadoes flower-fence; *Cæsalpinia*, brafiletto; *Guilandina*, bonduc, or nichar-tree; *Gnajacum*, lignum vitæ; *Cynometra*;

BOTANY.





Genera of Plants. - N. 2.

London, P. Aylmer, and the Art Director, No. 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, 34, 37, 40, 43, 46, 49, 52, 55, 58, 61, 64, 67, 70, 73, 76, 79, 82, 85, 88, 91, 94, 97, 100, 103, 106, 109, 112, 115, 118, 121, 124, 127, 130, 133, 136, 139, 142, 145, 148, 151, 154, 157, 160, 163, 166, 169, 172, 175, 178, 181, 184, 187, 190, 193, 196, 199, 202, 205, 208, 211, 214, 217, 220, 223, 226, 229, 232, 235, 238, 241, 244, 247, 250, 253, 256, 259, 262, 265, 268, 271, 274, 277, 280, 283, 286, 289, 292, 295, 298, 301, 304, 307, 310, 313, 316, 319, 322, 325, 328, 331, 334, 337, 340, 343, 346, 349, 352, 355, 358, 361, 364, 367, 370, 373, 376, 379, 382, 385, 388, 391, 394, 397, 400, 403, 406, 409, 412, 415, 418, 421, 424, 427, 430, 433, 436, 439, 442, 445, 448, 451, 454, 457, 460, 463, 466, 469, 472, 475, 478, 481, 484, 487, 490, 493, 496, 499, 502, 505, 508, 511, 514, 517, 520, 523, 526, 529, 532, 535, 538, 541, 544, 547, 550, 553, 556, 559, 562, 565, 568, 571, 574, 577, 580, 583, 586, 589, 592, 595, 598, 601, 604, 607, 610, 613, 616, 619, 622, 625, 628, 631, 634, 637, 640, 643, 646, 649, 652, 655, 658, 661, 664, 667, 670, 673, 676, 679, 682, 685, 688, 691, 694, 697, 700, 703, 706, 709, 712, 715, 718, 721, 724, 727, 730, 733, 736, 739, 742, 745, 748, 751, 754, 757, 760, 763, 766, 769, 772, 775, 778, 781, 784, 787, 790, 793, 796, 799, 802, 805, 808, 811, 814, 817, 820, 823, 826, 829, 832, 835, 838, 841, 844, 847, 850, 853, 856, 859, 862, 865, 868, 871, 874, 877, 880, 883, 886, 889, 892, 895, 898, 901, 904, 907, 910, 913, 916, 919, 922, 925, 928, 931, 934, 937, 940, 943, 946, 949, 952, 955, 958, 961, 964, 967, 970, 973, 976, 979, 982, 985, 988, 991, 994, 997, 1000.

Cynometra; Swietenia, mahogany-tree; and Dictamnus, fraxinella, or white dittany. 2. Such as have erect stamina, of which there are forty-one, viz. Ruta, rue; Tolvisera, balsam of tolu tree; Hematoxylum, log-wood; Adenantha, base flower-fence; Melia, bread-tree; Trichilia; Zygophyllum, bean-caper; Quassia, Simarouba bark; Fagonia; Tribulus, caltrops; Thryallis; Murraya; Monotropā, bird's-nest; Jusseiauau; Limonia; Melastoma, American gooseberry; Kalmia, dwarf American laurel; Ledum, marsh cistus, or wild rosemary; Quisqualis; Dais; Bergera; Bucida; Copaifera, balsam copivi tree; Samyda; Rhododendron, dwarf rose-bay; Andromeda, base-heath; Epigaea, trailing arbutus; Gualtheria, Canadian vine; Arbutus, strawberry-tree; Clethra; Pyrola, winter-green; Prosopis; Heisteria; Chalcas; Codon; Styra, storax-tree; Turræa; Dionæa, Venus's fly-trap; Ekebergia; Inocarpus; and Myroxylon, balsam of Peru.

Order 2. DIGYNIA, comprehending such plants as have two pistilla. Of this order there are twelve genera, viz. Royena, African bladder-nut; Hydrangea; Cunonia; Chrysosplenium, golden saxifrage; Saxifraga, saxifrage; Tiarella, American fanicle; Milella, base American fanicle; Scleranthus, German knot-grass, or knawel; Trianthema, horse purslane; Gysophila; Saponaria, soap-wort; and Dianthus, pink, carnation, &c.

Order 3. TRIGYNIA, comprehending such plants as have three pistilla. Of this order there are twelve genera, viz. Cucubalus, berry-bearing chickweed; Silene, viscous campion; Stellaria, greater chickweed; Arenaria, sandwort; Cherleria; Garidella, fennel-flower of Crete; Malpighia, Barbadoes cherry; Banisteria; Triopteris; Erythroxylum; Hiræa; and Deutzia.

Order 4. PENTAGYNIA, comprehending such plants as have five pistilla. Of this order there are fourteen

fourteen genera, viz. *Averrhoa*; *Spondias*, hog-plum; *Cotyledon*, navel-wort; *Sedum*, lesser house-leek; *Penthorum*; *Oxalis*, wood-forrel; *Suriana*; *Lychnis*, campion; *Agrostemma*, rose-campion, or wild lychnis; *Cerastium*, mouse-ear chickweed; *Spergula*, spurray; *Grielum*; *Forstkohlea*; and *Bergia*.

Order 5. *DECAGYNIA*, comprehending such plants as have ten pistilla. This order contains two genera, viz. *Neurada*; and *Phytolacca*, American nightshade.

EXAMPLE FOR INVESTIGATION.

The simple plant now chosen for consideration, is the *Stellaria*, or greater chickweed, which, in the magnified state here represented, has the advantage of showing out all the parts of fructification in the most obvious manner. *CALYX*, fig. 3; a perianthium pentaphyllous, the folioles or leaflets ovately lanceolate, concave, acute, patent, permanent. *COROLLA*, *a*, fig. 4; the petals five, bipartite, plain, oblong, marcescent, or withering on the plant. *STAMINA*, marked *s*; the filaments ten, filiform, shorter than the corolla; alternately long and short; antheræ cordate; or heart-shaped. *PISTILLUM*, marked *p*; the germen, *g*, subrotund; styles three, filiform, spreading; stigmas obtuse. *PERICARPIUM*, fig. 5; a capsule, ovate, close, unilocular, sex-valvular. *SEEDS*, *b*, magnified; many, subrotund, compressed, lying loose in the capsule.

CLASS XI. DODECANDRIA.

To discriminate accurately the genera arranged under this head, will require particular attention from a learner; because, although the significant term appropriated to this class would induce us to suppose that each of the flowers contained *twelve* stamina; yet, in fact, it is an assemblage of plants whose blossoms bear from *twelve* to *nineteen* stamina, inclusive.

Though

Though still, the plant *Tormentilla* affords an exception to the rule; for, though it has precisely sixteen stamina, it does not belong to this class. The reason is, because the other characters in its fructification over-rule the number of the male parts, and assign it a place in the class *Icosandria*. The *Euphorbia*, or spurge, is the most difficult genus in the whole of the present class, occasioned by the number of stamina being generally uncertain; those which do exist standing forth only a few at a time, and the effusion of milky juice abounding in these plants, makes the dissection of the flowers very difficult to accomplish. But these difficulties will soon be got over by patience and perseverance. The orders into which the *Dodecandria* plants are divided, are five, as follow:

Order 1. *MONOGYNIA*, comprehending such plants as have but one pistillum. This order contains twenty-five genera, viz. *Asarum*, asarabacca; *Gethyllis*; *Bocconia*, tree, celandine; *Rizophora*, mangrove, or candle of the Indians; *Blakea*; *Garcinia*, mangostan; *Winterana*; *Cratæva*, garlic pear; *Triumfetta*, bur bark-tree; *Bassia*; *Peganum*, wild Syrian rue; *Halefia*, snow-drop tree; *Nitraria*; *Portulacca*, purslane; *Hudsonia*; *Lythrum*, willow-herb; *Ginora*; *Decumaria*; *Befaria*; *Vatica*; *Apac-tis*; *Canella*, white cinnamon; *Dodecas*; *Eurya*; and *Aristotelia*. *Gethyllis* is now removed into the first order of the class *Hexandria*.

Order 2. *DIGYNIA*, comprehending such plants as have two pistilla. Of this order there are two genera, viz. *Heliocarpus*, sun-seed; and *Agrimonia*, agrimony.

Order 3. *TRIGYNIA*, comprehending such plants as have three pistilla. This order contains five genera, viz. *Reseda*, mignonette, or base rocket; *Euphorbia*, burning thorny plant, or spurge; *Pallasia*; *Tacca*; and *Visnea*.—*Pallasia*, an obscure genus, is

removed into the class Syngenesia, order Polygamia frustranea.

Order 4. PENTAGYNIA, comprehending such plants as have five pistilla. This order contains but one genus, viz. *Glinus*.

Order 5. DODECAGYNIA, comprehending such plants as have twelve stamina. This order contains but one genus, viz. *Sempervivum*, houseleek.

EXAMPLES FOR INVESTIGATION.

The plant *Asarum*, or asarabacca, in the first order of this class, affording a very curious and beautiful fabric in its fructification, we shall bring under examination that plant, and then give a dissection of the more obscure genus *Euphorbia*. The species of *Asarabacca* delineated in Plate XII. is the Canadian, which is hairy, and larger than the European plant. CALYX, fig. 6; a perianthium monophyllous, campanulate or bell-shaped, semitrifid, coriaceous, coloured, villous, permanent; lacinias or clefts erect, acuminate, ovate, bent in at the top. COROLLA, none. STAMINA, *s*, fig. 7; which shows the fructification in a more advanced state: the filaments twelve, surrounding the pistillum, subulate, shorter than the calyx; antheræ oblong, fastened to the middle partition of the filaments, as shown at fig. 8, which represents the whole stamina taken out of the flower. PISTILLUM, *p*; the germen *g*, below the calyx, and concealed within its substance; style, a cylindraceous cone, thick, obtuse, hexagonal, the length of the stamens; stigma stellate, or star-shaped, sexpartite, the lacinias obtuse, reflexed. PERICARPIUM, fig. 9; a capsule, ovate, covered with the dry calyx, coriaceous, with six loculaments. SEEDS: several, ovate, shown at *a* of their natural size. Fig. 10. a transverse section of the pericarpium, to show the loculaments or seed vessels.

To illustrate the difficult genus *Euphorbia*, we have chosen

chosen the species *lathyris*; it is a native of France and Italy, and has been cultivated in the English gardens ever since the time of Gerard. CALYX, *aa*, fig. 11. a perianthium monophyllous, ventricose, coloured, dentate or four-toothed at the mouth, permanent. COROLLA, *bb*; the petals four, (in some few five,) turbinate, gibbous, swelled, truncate, unequal, standing alternate with the denticles or teeth of the calyx, as at fig. 12. which represents the blossom stretched out; *cc*, the teeth of the calyx: the unguis or claws of the petals are placed on the margin of the calyx, permanent. The petals do the office of a nectarium. STAMINA, marked *s*, fig. 11; the filaments many (twelve or more,) filiform, articulate, inserted on the receptacle, longer than the corolla, coming out through the corolla at different times; antheræ twin, subrotund. PISTILLUM, *p*; the germen, *g*, subrotund, triquetrous, pedicelled, or having a footstalk; styles three, bifid; stigmas obtuse. PERICARPIUM, fig. 13; a capsule, subrotund, trilocous, trilocular, starting open with an elastic force. SEEDS: solitary, i. e. one in each cell, subrotund.

CLASS XII. ICOSANDRIA.

Although this is called the class of *twenty* stamens, because the flowers arranged under it generally contain about that number; yet the classic character is not to be taken merely from the number of stamens, but from a consideration of the following circumstances, which will sufficiently distinguish it both from the preceding and ensuing classes. 1. CALYX consisting of one leaf, concave. 2. PETALS fixed by claws to the inside of the calyx. 3. STAMENS more than nineteen; standing upon the petals, or upon the calyx; but not upon the receptacle. Some few botanists have lately abolished this class, and removed the genera into the next class, Polyandria; but the

method is not much followed. The orders, as arranged by Linnæus, are as follow:

Order 1. **MONOGYNIA**, comprehending such plants as have but one pistillum. This order contains eleven genera, viz. Cactus, melon-thistle; Eugenia, pomey-rose; Philadelphus, syringa, or mock orange; Pfidium, guava, or bay-plum; Myrtus, myrtle; Punica, pomegranate; Amygdalus, almond-tree; Prunus, plum-tree; Plinia; Chrysobalanus, cocoa-plum; and Sonneratia.

Order 2. **DIGYNIA**, comprehending such plants as have two pistilla. Of this order there is but one genus, viz. Cratægus, wild service-tree.

Order 3. **TRIGYNIA**, comprehending such plants as have three pistilla. This order contains two genera, viz. Sorbus, service-tree; and Sesuvium.

Order 4. **PENTAGYNIA**, comprehending such plants as have five pistilla. This order contains six genera, viz. Mespilus, medlar; Pyrus, pear; Tetragonia; Mesembryanthemum, fig-marygold; Aizoon; and Spiræa, spiked willow, or drop-wort.

Order 5. **POLYGYNIA**, comprehending such plants as have many pistilla. This order contains nine genera, viz. Rosa, rose; Rubus, raspberry, or strawberry; Fragaria, strawberry; Potentilla, cinquefoil; Tormentilla, tormentil; Geum, avens, or herb bennet; Dryas; Comarum, marsh cinquefoil; and Calycanthus, Virginian allspice.

EXAMPLE FOR INVESTIGATION.

The plant we have now before us is the Rubus, or common bramble; easy to examine, because every where to be found; the parts of fructification are also very obvious and striking: it is the wild raspberry, ranking in the fifth order of this class. **CALYX**, Plate XII. fig. 14; a perianthium monophyllous, quinquepartite, the leaflets oblong, acuminate, patent, permanent.

permanent. COROLLA, fig. 15; the petals five, subrotund, length of the calyx, patent, inserted in the calyx. STAMINA, a large cluster, marked *s*; filaments many, shorter than the corolla, inserted in the calyx; antheræ subrotund, compressed. PISTILLUM, *p*; the germens numerous; styles filiform, coming out of the sides of the germens; stigmas simple. PERICARPIMUM, fig. 16; composed of little berries, united in a convex head, concave underneath; each berry, or acinus, unilocular; *a*, the receptacle of the fruit. SEEDS, *b*, single, oblong.

CLASS XIII. POLYANDRIA.

The flowers of this class have, as its title implies, many stamens, from twenty to a thousand, perhaps sometimes more; so that it is unnecessary to attempt to count them, further than to be satisfied that they amount to twenty or upwards. The situation of the stamina, as standing upon the receptacle, is sufficient to distinguish it from the preceding class, in which they do not stand upon the receptacle, but either upon the sides of the calyx, or else upon the petals. A regard to this circumstance in this class, will be a surer guide to the young botanist, than an attention merely to the number of stamina. If the eye does not at once determine the exact situation of the stamens, carefully and slowly pull off the petals, and the segments of the calyx; if the stamens afterwards remain fixed in their place, they may then be considered as growing upon the receptacle. Most of the plants in this class are noxious and unwholesome. They are divided into the seven orders following:

Order 1. MONOGYNIA, comprehending such plants as have but one pistillum. This order contains forty-two genera, distinguished into, 1. Such as have scarcely any style, of which there are thirteen, viz. *Marcgravia*; *Rheedia*; *Capparis*, caper-bush; *Aetua*, herb Christopher; *Sanguinaria*, puccoon, or blood-root;

root; Podophyllum, duck's-foot, or May-apple; Chelidonium, celandine; Papaver, poppy; Argemone, prickly-poppy; Muntingia; Cambogia; Saracenian, side-saddle flower; and Nymphæa, water-lily. 2. Such as have a style of some length, of which there are twenty-nine, viz. Bixa, anotta; Sloanea, apeiba of the Brazils; Mammea, mammee-tree; Ochna; Calophyllum; Grias; Tilia, lime-tree; Laetia; Elæocarpus; Lecythis; Vateria; Lagerstroemia; Thea, tea-tree; Caryophyllus, clove-tree; Mentzelia; Delima; Cistus, rock-rose; Prockia; Corchorus, Jew's mallow; Seguiera; Loofa; Trewia; Trilix; Alstonia; Clevera; Sparrmannia; Ternstroemia; Bonnetia; and Vallea.

Order 2. DIGYNIA, comprehending such plants as have two pistilla. This order contains four genera, viz. Pæonia, peony; Calligonum; Curatella; and Fothergilla.

Order 3. TRIGYNIA, comprehending such plants as have three pistilla. This order contains two genera, viz. Delphinium, larkspur; and Aconitum, wolf's-bane.

Order 4. TETRAGYNIA, comprehending such plants as have four pistilla. This order contains three genera, viz. Tetracera; Caryocar; and Cimicifuga.

Order 5. PENTAGYNIA, comprehending such plants as have five pistilla. This order contains four genera, viz. Aquilegia, columbine; Nigella, fennel-flower, or devil in a bush; Reaumuria; and Brathys. This last plant, Brathys, being now considered as a species of Hypericum, is removed under that genus, in the class Polyadelphia.

Order 6. HEXAGYNIA, comprehending such plants as have six pistilla. This order contains but one genus, viz. Stratiotes, water-soldier.

Order 7. POLYGYNIA, comprehending such plants as have many pistilla. This order contains twenty-

twenty-one genera, viz. *Dillenia*; *Liriodendron*, tulip-tree; *Magnolia*, laurel-leaved; tulip-tree; *Michelia*; *Uvaria*; *Annona*, custard-apple; *Anemone*, wind-flower; *Atragene*; *Clematis*, virgin's bower; *Thalictrum*, meadow-rue; *Adonis*, pheasant's eye; *Illicium*, anniseed-tree; *Ranunculus*, crowfoot; *Trollius*, globe ranunculus; *Isopyrum*; *Helleborus*, black hellebore; *Caltha*, marsh marigold; *Hydrastis*, yellow root; *Houttuynia*; *Unona*; and *Wintera*, winter's bark.

EXAMPLE FOR INVESTIGATION.

For the further illustration of this class, we have selected the plant *Aquilegia*, or columbine, which belongs to the fifth order. It has a place in most gardens, and is therefore easy to investigate. CALYX, none. COROLLA, marked *a*, fig. 17; the petals five, lanceolate-ovate, plain, patent, equal. NECTARIUM, marked *n*; consisting of five interior florets, placed alternately with the petals, horned, or terminating downwards in a hollow claw, all united inwardly to the receptacle; growing gradually wider upwards, with an oblique mouth, obtuse at the top. Fig. 18; shows one of the nectaries distinct, taken out of the flower. STAMINA, marked *s*; the filaments many, from thirty to forty, subulate, the outer ones shorter; antheræ oblong, erect, the height of the nectaries. PISTILLUM, *p*; the germens, *g*, five, ovate-oblong, terminating in subulate styles, longer than the stamina; stigmas erect, simple; paleas, or chaffs, ten, rugous, short, separating and inclosing the germens. PERICARPIUM, fig. 19; five capsules, standing upon the receptacle, parallel, erect, acuminate, cylindric, univalve, opening inwardly at the apex. SEEDS, marked *b*; numerous, ovate, keeled, joined to the opening sutures.

CLASS XIV. DIDYNAMIA.

The essential character of this class consists in the flowers being furnished with four stamina, two of which are *long* and two *short*. The short stamens stand next together, and adjoining to the style of the pistillum. They are covered by the blossom, which is irregular in its shape. This class comprehends the whirled, the lipped, the masked, the gaping, and the grinning, flowers of former authors. The structure of the fructification in this class is so much alike in all the genera, that, when the general characters are known, all the plants may be easily distinguished by them. They are as follow :

CHARACTERS of the CLASS DIDYNAMIA.

CALYX: A perianthium, monophyllous, erect, tubulate, quinquefid, with segments for the most part unequal, and persisting.

COROLLA: Monopetalous and erect, the base of which contains the honey, and performs the office of a nectarium. The upper lip straight, the lower spreading and trifid. The middle lacinia or segment the broadest.

STAMINA: Four filaments, subulate, inserted in the tube of the corolla, and inclined towards the back of it. The two nearest the shortest. All of them parallel, and rarely exceeding the length of the corolla. The antheræ lodged under the upper lip of the corolla in pairs; in each of which respectively the two antheræ approach each other.

PISTILLUM: The germen commonly above the receptacle. The style single, filiform, bent in the same manner as the filaments, and usually placed within them, a little exceeding them in length, and slightly curved towards the summit. The stigma for the most part emarginate.

PERICARPIUM: Either wanting, as in the first order;

der; or, if present, usually bilocular, as in the second order; sometimes, though rarely, quadrilocular.

SEEDS: If no pericarpium, four, lodged within the hollow of the calyx, as in a capsule; but, if there be a pericarpium, more numerous, and fastened to a receptacle placed in the middle of the pericarpium.

—The flowers of this class are, for the most part, nearly upright, but leaning a little from the stem, that the blossom may more effectually cover the antheræ from the rain, and the pollen more easily fall upon the summit. The plants in the first order of this class are odoriferous, cephalic, and resolvent. None of them are poisonous. The orders are only two, viz.

Order 1. GYMNOSPERMIA, comprehending such plants as have naked seeds. This order hath these farther characters, viz. the seeds four (excepting Phryma, which is monospermous); and the stigma bipartite, and acute, with the lower lacinia reflexed. It contains thirty-four genera, distinguished into, 1. Such as have the calyx quinquefid, and nearly equal, of which there are twenty, viz. Ajuga, bugle; Teucrium, germander; Satureja, savory; Thymra, mountain hyssop; Hyssopus, hyssop; Nepeta, nep, or catmint; Lavandula, lavender; Betonica, betony; Sideritis, iron-wort; Mentha, mint; Glechoma, gill, or ground-ivy; Perilla; Lamium, dead-nettle, or archangel; Galeopsis, hedge-nettle; Stachys, base horehound; Ballota, black horehound; Marrubium, horehound; Leonurus, lion's-tail; Phlomis, Jerusalem sage; and Molucella, Molucca balm. 2. Such as have the calyx bilabiate, (divided into two lips;) of which there are fourteen, viz. Clinopodium, field basil; Origanum, wild marjoram; Thymus, thyme; Melissa, balm; Dracocephalum, dragon's-head; Horminum, Pyrenæan clary; Melittis, balm-leaved archangel, or base balm; Ocimum, basil; Trichostema; Scutellaria, scull-cap; Prunella, self-heal; Cleonia; Prasium, shrubby hedge-nettle; and Phryma.

Order 2. **ANGIOSPERMIA**, comprehending such plants as have the seeds in a pericarpium, which circumstance is constant, and distinguishes this order from the last in every form. To this character may be added that of a stigma commonly obtuse. This order contains sixty-nine genera, distinguished into, 1. Such as have a simple stigma, and perispermate corollæ; of which there are thirteen, viz. *Barbarea*; *Rhinanthus*, elephant's-head; *Euphrasia*, eyebright; *Melampyrum*, cow-wheat; *Lathræa*; *Schwalbea*; *Tozzia*; *Pedicularis*, rattle-coxcomb, or louse-wort; *Gerardia*; *Chelone*, humming-bird tree; *Gelneria*; *Antirrhinum*, snap-dragon, or calve's-snout; and *Cymbaria*. 2. A simple stigma and spreading corolla, of which there are thirty, viz. *Craniofolia*; *Martynia*; *Torenia*; *Scrophularia*, fig-wort; *Celsia*; *Digitalis*, fox-glove; *Bignonia*, trumpet-flower; *Brunfelsia*; *Citharexylum*, fiddle-wood; *Halleria*, African fly honeysuckle; *Crescentia*, calabash-tree; *Gmelina*; *Petrea*; *Lantana*, American viburnum; *Cornutia*; *Loeselia*; *Capraria*, sweet-weed; *Selago*; *Hebenstreitia*; *Erinus*; *Buchnera*; *Browallia*; *Linnaea*; *Sibthorpia*, base money-wort; *Limosella*, mud-wort, or least water-plantain; *Hemimeris*; *Castilleja*; *Millingtonia*; *Thunbergia*; and *Amasonia*. 3. With a double stigma; of which there are twenty-five, viz. *Stemodia*; *Obolaria*; *Orobanche*, broom-rape; *Dordartia*; *Lippia*; *Sesamum*, oily purging-grain; *Mimulus*, monkey-flower; *Ruellia*; *Barleria*; *Durania*; *Ovieda*; *Volkameria*; *Clerodendrum*; *Vitex*, agnus castus, or chaste-tree; *Bontia*; *Barbadoes* wild olive; *Columnnea*; *Acanthus*, bear's-breech; *Pedallum*; *Avicennia*; *Vandellia*; *Manulea*; *Belteria*; *Lindernia*; *Premna*; and *Hyobanche*. 4. Such as have many petals, of which there is but one genus, viz. *Melianthus*, honey-flower.

EXAMPLE FOR INVESTIGATION.

The subject here chosen for examination is the *Melianthus*, or honey-flower. The parts of fructification are extremely obvious: the flower is perfectly bilabiate; its upper lip is constructed of the four superior lacinias or segments of the calyx, and the erect petalum; its under lip consists of the bag-shaped lacinia in the calyx, with the four petals that have the reflected points. Its anatomical description is as follows; CALYX, fig. 20; a perianthium quinquepartite, large, unequal, coloured; the two superior segments oblong, erect; the single under one very short, shaped like a bag, gibbous downwards; the two middle segments opposite, interior, lanceolate; the two upper ones simple. COROLLA: the petals five, lanceolate; the upper one erect, simple; the other four on the upper side patent, reflecting at the apices. Fig. 21, shows the calyx expanded, with the corolla, stamina, &c. placed upon it; *a a*, the segments of the calyx; *b b*, the petals of the corolla. NECTARIUM, marked *n*; monophyllous, placed within the bag-like segment of the calyx, very short, compressed at the sides, cut on the margin, the back declining. STAMINA, *s*; the filaments four, subulate, erect, two long, two short; antheræ cordate, oblong, on the fore part quadrilocular. PISTILLUM, *p*; the germen, *g*, tetragonous, gibbous, four-toothed; style erect, subulate, of the length of the stamens; stigma quadrifid. PERICARPium, fig. 22; a capsule, quadrangular, quadrilocular, semiquadrifid; the angles acute, distant; the loculaments or cells inflated; the dissepiment opening in the centre, gaping between the angles. SEEDS: four, subglobous, fixed in the centre of the capsule.

CLASS XV. TETRADYNAMIA.

In the flowers of this class are six stamina; *four*
 Y 2 of

of them long, and *two* short. It is also worthy of observation, that the flowers of this class have uniformly four petals. An attention to this circumstance will probably save the learner some trouble, as the difference of length in the stamens is not always very obvious, and especially as the plants of the Hexandria class have none of them four petals. The orders are two, and are distinguished by the figure of the seed-vessel, which, in the first order is a broad and globular pod; that is, a roundish flat seed-vessel, furnished with a style, which is frequently as long as the seed-vessel itself. In the second order, the seed-vessel is a filiqua or long pod; that is, a very long seed-vessel, without any remarkable style. The plants of this class also admit of the following distinguishing

NATURAL CHARACTER.

CALYX: A perianthium tetraphyllous and oblong; the leaves of which are ovate-oblong, concave, obtuse, conniving, gibbous downwards at the base, the opposite ones equal and deciduous. The calyx in these flowers contains the nectarium; which is the reason of the base being gibbous.

COROLLA: Cruciform, or cross-shaped. Four equal petals. The claws plane-subulate, erect, and somewhat longer than the calyx. The limbs plane, widening outwards, obtuse, the sides hardly touching one another. The insertion of the petals is in the same circle with the stamina.

NECTARIUM: Nectariferous glands, which differ in different genera, grow near the stamens, and are mostly fixed at the base of the shorter filaments, which are generally bent outwards, to prevent the compression of the glands, and therefore appear shorter than the others.

STAMINA: The filaments six, subulate; of which two that are opposite are of the length of the calyx; the other four somewhat longer, but not so long as the corolla. The antheræ oblong, acuminate, thicker

at

at the base, erect, and with their tops leaning outwards.

PISTILLUM: The germen above the receptacle, constantly increasing in height. The style either of the length of the longer stamina, or wanting. The stigma obtuse.

PERICARPIUM: A siliqua or pod, of two valves, often bilocular, opening from the base to the top. The dissepiment projecting at the top beyond the valves, the prominent part thereof having before served as a style.

SEEDS: Roundish, inclining downwards, alternately plunged lengthwise into the dissepiment. The receptacle linear, surrounding the dissepiment, and immersed in the sutures of the pericarpium.—This class is truly natural, and has been assumed as such by all the best systematic writers; nevertheless, they have thrown into it one or more genera that do not naturally belong to it; Linnæus thinks he has given no wrong one, unless it be *Cleome*. The plants of this class are universally called antiscorbutic, their taste is acrid and watery; they lose most of their virtues by drying. None of them are poisonous. In most situations, and wet seasons, they are most acrimonious. Thus the *Cochlearia armoracia*, horseradish, growing near water, is so very acrid, that it can hardly be used; and *Brassica rapa*, the turnip, whose root in a dry sandy soil is so succulent and sweet, in wet stiff lands is hard and acrimonious.

Order 1. SILICULOSA, comprehending those plants whose pericarpium is a *silicula*, or short globular pod. This order contains fourteen genera, viz. *Myagrum*, gold of pleasure; *Vella*, Spanish cress; *Anastatica*, rose of Jericho; *Subularia*, awl-wort, or rough-leaved alysson; *Draba*, whitlow-grass; *Lepidium*, dittander, or pepper-wort; *Thlaspi*, mithridate mustard; *Cochlearia*, scurvy-grass, or spoon-wort; *Iberis*, candy-tuft, or sciatic cress; *Alyssum*, mad-wort;

wort; *Peltaria*; *Clypeola*, treacle-mustard; *Biscutella*, buckler-mustard; and *Lunaria*, moon-wort, fat-tin-flower, or honesty.

Order 2. *SILIKUOSA*, comprehending those plants whose pericarpium is a *siliqua*, or long pod. This order contains eighteen genera, viz. *Ricotia*; *Dentaria*, tooth-wort; *Cardamine*, lady's-smock; *Sisymbrium*, water-cress; *Erysimum*, hedge-mustard; *Cheiranthus*, stock July-flower; *Heliophila*; *Hesperis*, dame's violet, or queen's July-flower; *Arabis*, base tower-mustard; *Turritis*, tower-mustard; *Brassica*, cabbage; *Sinapis*, mustard; *Raphanus*, radish; *Bunias*, sea-rocket; *Isatis*, woad; *Crambe*, sea-cabbage, or kale; *Cleome*, base-mustard; and *Chamira*.

EXAMPLE FOR INVESTIGATION.

For the purpose of illustrating the genera in the class *Tetradynamia*, we have chosen the plant *Cheiranthus*, or stock July-flower, belonging to the second order, *Silikuosa*; which plant the young botanist may find in almost every garden. *CALYX*, fig. 23, *a*; a perianthium tetraphyllous, compressed; the segments lanceolate, concave, erect, parallel-converging, deciduous; the two exterior gibbous at the base. *COROLLA*, *b*; tetrapetalous, cruciform; the petals roundish, longer than the calyx; claws the length of the calyx. *NECTARIUM*, fig. 24, *c*; glands, surrounding the base of the shorter stamens, on each side. *STAMINA*, *s*; the filaments six, subulate, parallel, the length of the calyx, two of them within the gibbous segments of the calyx, shorter than the other four; antheræ erect, bifid at the base, acute at the tip, and reflected. *PISTILLUM*, *p*; the germen, *g*, prismatic, four-cornered, the length of the stamens, with a tubercle on each side; style very short, compressed; stigma ovate, bipartite, reflected, thickish, permanent. Fig. 24, is the stamina and pistillum taken out of the flower,

flower, and magnified, to show the parts. **PERICARP-
RIUM**, fig. 25; a siliqua, or long pod, compressed,
the two opposite angles obliterated, marked with a
toothlet, bilocular, bivalvular; retaining the very
short style, and the erect bifid stigma. **SEEDS**, *d*;
many pendulous, fixed alternately to each suture,
subrotund, compressed, having a membranaceous
margin.

CLASS XVI. MONODELPHIA.

In this class the filaments are all united together at
the bottom, but separate at the top. The orders are
determined by the number of the stamens; and the
flowers are distinguishable by the following

NATURAL CHARACTER.

CALYX: A perianthium always present, persisting,
and in most genera double.

COROLLA: Pantapetalous, the petals inversely
heart-shaped; the sides of which lap each one over
the next, contrary to the motion of the fan, or from
the right to the left.

STAMINA: The filaments united below, but dis-
tinct upwards if there be more than one. The ex-
terior ones shorter than the interior. The anthers
incumbent.

PISTILLUM: The receptacle of the fructification
prominent in the centre of the flower. The germens
erect, surrounding the top of the receptacle in a
jointed ring. The styles are all united below in one
substance with the receptacle, but divided above into
as many threads as there are germina. The stigma
spreading and thin.

PERICARPRIUM: A capsule divided into as many
loculaments as there are pistilla. Its figure various
in the different genera.

SEEDS: Kidney-shaped.—The corolla in this class
has been considered by Tournefort as monopetalous;
but,

but, since the petals are all distinct at the base, it may be styled more properly pentapetalous, notwithstanding the petals cohere by the union of the stamina. The fruit in this class does not afford sufficient marks whereby to distinguish the genera; but the calyx is of the utmost importance, and furnishes invariable characters. The petals are truly a continuation of the cylindrical sheath, formed by the united filaments, which incloses the styles and germens as it descends; when rising upwards, it spreads out into petals. The plants of this class are esteemed to be emollient and mucilaginous. The orders are eight, viz.

Order 1. TRIANDRIA, comprehending such plants as have three stamina. This order contains two genera, viz. Aphyteia; and Galaxia.

Order 2. PENTANDRIA, comprehending such plants as have five stamina. This order contains five genera, viz. Waltheria; Lerchea; Hermannia; Melochia; and Symphonia.

Order 3. OCTANDRIA, comprehending such plants as have eight stamina. Of this order there is but one genus, viz. Aitonia.

Order 4. DECANDRIA, comprehending such plants as have ten stamina. This order contains three genera, viz. Connarus, Ceylon sumach; Geranium, cranes's-bill; and Hugonia.

Order 5. ENNEANDRIA, comprehending such plants as have nine stamina. Of this order there is but one genus, viz. Dryandra.

Order 6. ENDECANDRIA, comprehending such plants as have eleven stamina. Of this order there is only one genus, viz. Brownea.

Order 7. DODECANDRIA, comprehending such plants as have twelve stamina. This order contains two genera, viz. Pentapetes; and Monsonia.

Order 8. POLYANDRIA, comprehending such plants as have many stamina. This order contains twenty-one genera, viz. Bombax, silk cotton-tree; Sida,

Sida, Indian mallow; Adansonia, Ethiopian four gourd, or monkies'-bread; Althæa, marsh-mallow; Alcea, hollyhock, or rose-mallow; Malva, mallow; Lavatera, mallow-tree; Malope, base mallow; Urena, Indian mallow; Gossypium, cotton-tree; Hibiscus, althea frutex, or Syrian mallow; Stewartia; Camellia, Japan rose; Morisonia; Mesua, Indian rose-chestnut; Malachra; Gordonia, loblolly-bay; Gustavia; Caroleia; Barringtonia; and Solandra. This last genus is now removed into the class Pentandria, order Monogynia.

EXAMPLE FOR INVESTIGATION.

The plant here selected to demonstrate the characters of the genera in the class Monadelphia, is the Geranium, or crane's-bill, belonging to the fourth order. CALYX, fig. 26; a perianthium, quinquepartite, the laciniæ or segments lanceolate, acute, concave, permanent. COROLLA, fig. 27; the petals five, obcordate, patent or spreading, large. NECTARIUM, *n*; five honied glands, fastened to the base of the filaments. STAMINA, *s*; the filaments ten, subulate or awl-shaped, connected slightly at the base, distinct at the top, shorter than the corolla; antheræ ovate, versatile. PISTILLUM, *p*; the germen, *g*, fig. 28; quinqueangular, rostrated or beaked; style subulate, longer than the stamina, permanent; stigmas five, reflex. PERICARPIUM, fig. 29; a capsule five-grained, beaked, the cells opening inwards, each having a simple naked tail fixed to it. SEEDS, *æ*; one in each cell, oblong.

CLASS XVII. DIADELPHIA.

This class comprehends the butterfly-shaped flowers, and the leguminous plants of some authors. Linnæus takes the classic character from the *disposition*, and the character of the orders from the *number*, of the stamens. From the title of this class, the young

botanist will be led to imagine, that the filaments are always formed into two sets, but this is by no means the case; in many instances they are united into one set. The butterfly-shape of the blossom will, therefore, be a surer guide. If the student will take the flower of a garden-pea, and compare it with the following natural character, there will no longer remain any difficulty in pronouncing, at first sight, whether a plant belong to this class or not.

NATURAL CHARACTER.

CALYX: A perianthium monophyllous, campanulate, or bell-shaped, withering. The base gibbous, the lower part fastened to the peduncle, the upper obtuse and melliferous. The brim quinque-dentate; acute, erect, oblique, unequal. The lowest denticle longer than the rest; the upper pair shorter and farther asunder. The bottom of the cavity moist with a melleous liquor, including the receptacle.

COROLLA: Papilionaceous, or butterfly-shaped, unequal; the petals expressed by distinct names, viz. *Vexillum*, the standard; a petal covering the rest, incumbent, greater, plane-horizontal, inserted by its claw in the upper margin of the receptacle, approaching to a circular figure when it leaves the calyx, and nearly entire; along it, and especially towards its extremity, runs a line, or ridge, that rises up, as if the lower part of the petal had been compressed; the part of the petal next to the base, approaching to a semicylindric figure, embraces the parts that lie under it. The disk of the petal is depressed on each side, but the sides of it nearest the margin are reflected upwards. Where the halved tube ends, and the halved limb begins to unfold itself, are two concave impressions prominent underneath, and compressing the wings, which lie under them.—*Alæ*, the wings; are two equal petals, one at each side of the flower, placed under the *vexillum*; incumbent,

cumbent, with their margins parallel, roundish, or oblong, broader upwards, the upper margin straighter, the lower spreading more into a roundness; the base of each wing bifid, the lower division stretching out into a claw, inserted in the side of the receptacle, and about the length of the calyx; the upper short and inflexed.—*Carina*, the keel; the lowest petal, often bipartite, placed under the vexillum and between the alæ; boat-shaped, concave, compressed on the sides, set like a vessel afloat, mutilate at the base, the lower part of which runs into a claw of the length of the calyx, and inserted in the receptacle, but the upper and side laciniae are interwoven with that part of the alæ that is of the same shape. The form of the sides of the carina is much like that of the alæ; and so also is their situation, except that they are lower, and stand within them. The line that forms the carina, or keel, in this petal, runs straight as far as the middle, and then rises gradually in the segment of a circle, but the marginal line runs straight to the extremity, where, meeting the carinal, they terminate obtusely.

STAMINA: Called diadelphia. The filaments two, of different forms, viz. a lower one that involves the pistillum, and an upper one incumbent on it. The former of these, from the middle downwards, is cylindraceous, membranaceous, and split lengthwise on its upper side; but the upper half terminates in nine subulate parts, that are of the same length with, and follow the flexure of, the carina of the corolla, and of which the intermediate or lower radii are longer by alternate pairs. The upper filament is subulate-setous, covering the splitting of the former cylindraceous filament, incumbent on it, answering to it in situation, simple, and gradually shorter; its base is detached from the rest, and prepares an outlet for the honey on each side. The antheræ reckoned all together are ten, one on the upper filament and nine

on the lower, each of the radii being furnished with a single one: they are small, all of one size, and terminate the radii.

PISTILLUM: Single, growing out of the receptacle, within the calyx. The germen oblong, roundish, slightly compressed, straight, of the length of the cylinder of the lower filament which involves it. The style subulate, filiform, ascending, having the same length and position as the radii of the filaments, among which it is placed, and withering. The stigma downy, of the length of the style from the part turned upwards, and placed immediately under the antheræ.

PERICARPIUM: A legumen, oblong, compressed, obtuse, bivalved, with a longitudinal suture both above and below; each suture straight, though the upper one falls near the base, and the lower one rises near the top. The legumen opens at the upper suture.

SEEDS: Several, roundish, smooth, fleshy, pendulous, marked with an embryo that is a little prominent towards the point of insertion. When the young plant is excluded, the cotyledons preserve the form of the halved seed.

RECEPTACLE: The proper receptacles of the seeds are very small, very short, thinner towards the base, obtuse at the disk that fastens them, oblong, inserted longitudinally in the upper suture of the legumen only, but placed alternate; so that, when the valvulæ have been parted, the seeds adhere alternately to each of the valves.

This class is perfectly natural, and the structure of the flowers extremely singular: their situation is generally obliquely pendant. The figure of the legumen is not of so much consequence in ascertaining the genera as some have imagined; but the cup, or perianthium, which has been hitherto thought unworthy of notice, is of the greatest use. The leaves
never

never should be considered in forming the characters of genera. The seeds of this class furnish food for men, and other animals; they are farinaceous and flatulent. The leaves are food for cattle. None of them are poisonous. Dr. Pulteney, in a note added to his translation of the *Pan-Suecicus*, says, "A general view of this class shows at once how very acceptable its plants are to almost all cattle; cows and sheep refused none, and horses not more than three, out of the whole number with which they were tried. They afford the richest food for cattle, and are cultivated in divers parts of Europe with all possible attention. With us, the *trifolium pratense*, or clover, is mostly sown. Many trials have been made with the *hedy-sarum onobrychis*, or saintfoin, and some have thought that it answers better than clover. I say nothing of the exotic lucern. Among these plants the *anthyllis vulneraria* is particularly acceptable to sheep; insomuch, that the separate cultivation of it has been recommended; but it will not succeed well except on chalky grounds." See Dr. Pulteney's accurate and judicious work, entitled, *A General View of the Life and Writings of Linnæus*.—The orders under which the genera of this class are divided, are the following, viz.

Order 1. PENTANDRIA, comprehending such plants as have five stamina. Of this order there is only one genus, viz. *Monniera*.

Order 2. HEXANDRIA, comprehending such plants as have six stamina. This order contains two genera, viz. *Fumaria*, fumitory; and *Saraca*.

Order 3. OCTANDRIA, comprehending such plants as have eight stamina. This order contains three genera, viz. *Polygala*, milkwort; *Securidaca*, hatchet-vetch; and *Dalbergia*.

Order 4. DECANDRIA, comprehending such plants as have ten stamina. This order contains fifty genera, distinguished into, 1. Such as have monadelphous

phous filaments, or one set of brotherhoods; of which there are seventeen, viz. *Nissolia*; *Erythrina*, coral-tree; *Piscidia*, dogwood-tree; *Borbonia*; *Spartium*, broom; *Genista*, single-seeded broom; *Aspalathus*, African broom; *Amorpha*, shrubby base indigo; *Crotalaria*, rattle-wort; *Ononis*, root-harrow; *Anthyllis*, lady's-finger, or vetch; *Ebenus*, ebony of Crete; *Abrus*, Jamaica wild liquorice; *Pterocarpus*, red sanders; *Ulex*, furze, whins, or gorse; *Arachis*, ground-nut; and *Lupinus*, lupine. 2. Such as have diadelphous filaments, or two brotherhoods, and a downy stigma; of which there are ten, viz. *Phaseolus*, kidney-bean; *Dolichos*, cow-itch; *Glycine*, Carolina kidney-bean-tree; *Clitoria*; *Pisum*, pea; *Orobus*, bitter vetch; *Lathyrus*, chickling vetch; *Vicia*, vetch or tare; *Cicer*, chick-pease; and *Ervum*, bitter vetch. 3. Such as have diadelphous filaments, bilabiate calyces, and the stigma not downy, of which there are six, viz. *Cytisus*, trefoil-tree; *Geoffroya*, base cabbage-tree; *Robinia*, false acacia; *Colutea*, bladder senna; *Glycyrrhiza*, liquorice; and *Coronilla*, jointed-podded colutea. 4. Such as have diadelphous filaments, stigmata that are not downy, and calyces not bilabiate; of which there are seventeen, viz. *Ornithopus*, bird's-foot; *Hippocrepis*, horse-shoe vetch; *Scorpiurus*, caterpillars; *Hedysarum*, French honeysuckle; *Æschynomene*, base sensitive-plant; *Indigofera*, indigo; *Galega*, goat's-rue; *Phaca*, base milk-vetch; *Astragalus*, liquorice-vetch; or milk-vetch; *Biserrula*, base hatchet-vetch; *Psoralea*; *Trifolium*, trefoil; *Lotus*, bird's-foot trefoil; *Liparia*; *Trigonella*, fenugreek; *Medicago*, medic or moon trefoil; and *Mullera*.

EXAMPLE FOR INVESTIGATION.

After the very copious description of the natural character above given of the genera in this class, it is presumed that a correct delineation of the flower of any one genus will enable the young botanist, by analogy,

analogy, easily to discriminate all the genera belonging to the *Diadelphia* class. We have for this purpose selected the plant *Lathyrus*, called the everlasting pea, or chickling vetch, the parts of fructification in which are as follow. *CALYX*, fig. 30; a perianthium monophyllous, semiquinquedid, campanulate or bell-shaped; the lacinias or divisions lanceolate, acute; the three superior ones short, the two inferior ones longer. *COROLLA*, fig. 31; papilionaceous; the vexillum or standard, *a*, obcordate, the margin and apex reflexed; the alæ or wings, *b*, oblong, lunulate or moon-shaped, short, obtuse; the carina or keel; *c*, semiorbicular, of the magnitude of the wings, somewhat broader, opening internally. *STAMINA*, fig. 32; the filaments diadelphous; one stamen standing by itself, simple; the others in one body divided into nine; antheræ subrotund. *PISTILLUM*, *p*; germen, *g*, compressed, oblong, linear; style erect, flat, broader upwards, the apex acute; stigma, from the middle of the style to the apex, villous in the front. *PERICARPIUM*, fig. 33; a legumen or pod, long, compressed, acuminate, bivalve. *SEEDS*; many, reniform or kidney-shaped.

CLASS XVIII. POLYADELPHIA.

This class comprehends the plants whose flowers have their stamina *united* into *three* or more sets. In most species the filaments stand very close; but in some few they are so much separated, that, unless they are examined quite down to their base, the young botanist may easily mistake them for plants belonging to the classes *Icosandria* or *Polyandria*. The orders are three, arranged according to the number of stamens.

Order 1. *PENTANDRIA*, comprehending such plants as have five stamina in each set. Of this order there are two genera, viz. *Theobroma*, chocolate-nut; and *Abroma*.

Order

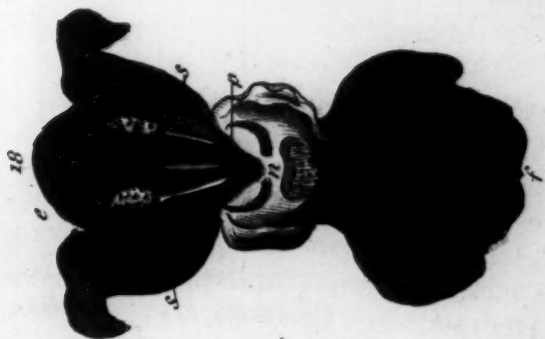
Order 2. **ICOSANDRIA**, comprehending such plants as have twenty stamina in each set. Of this order there is but one genus, viz. *Citrus*, citron.

Order 3. **POLYANDRIA**, comprehending such plants as have many stamina in each set. This order contains eight genera, viz. *Hypericum*, St. John's wort; *Ascyrum*, St. Peter's wort; *Hopea*; *Symplocos*; *Melaleuca*, cayputi-tree; *Durio*; *Munchausia*; and *Glabraria*.

EXAMPLE for INVESTIGATION.

As the principal art in ascertaining the genera belonging to the orders of this class, depends on detecting with accuracy the number of sets or brotherhoods in the stamina, and also the number of stamens in each set, we have selected the fructification of the *Citrus*, or orange, as best calculated to display the manner in which these parts are formed and united in the same corolla. **CALYX**, see the Botanical Plate XIII. fig. 1; a perianthium monophyllous, quinque-dentate, or five-toothed, plain at the base, marcescent, or withering on the plant. **COROLLA**, fig. 2; the petals five, oblong, obtuse, plain, patent. **STAMINA**, s; fig. 3; the filaments usually twenty, subulate, compressed, erect, standing in a cylinder, forming a circle round the pistillum, as in fig. 2; joined together in many or few brotherhoods or sets, as shown in fig. 3, which contains the stamina and pistillum taken from the blossom, and magnified. **PISTILLUM**, p; the germen, g, superior, ovate; style cylindric, thick, length of the stamina; stigma globular, having nine cells within. **PERICARPUM**, fig. 4; a bacca or berry, with a fleshy rind, (the orange;) having a bladdery pulp, enveloping nine loculaments or seed-vessels. **SEEDS**: in couples, i.e. two in each loculament, ovate, callous.





L. P. 1800.



Genera of Plants - N^o 3.

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CLASS XIX. SYNGENESIA.

This class consists of such plants as bear *compound* flowers; and we have already paved the way for understanding them, by the explanation given in p. 85. What is farther necessary here, is to give the natural character of the flowers. Compound flowers admit of a double description, viz. 1. of the whole flower in its aggregate state, which is termed the *flosculus* flower; and 2. of the *flosculi*, or *florets*, of which it is composed. We shall begin with the first, which concerns only the calyx and receptacle, those being the only parts that are alike in them all.

CHARACTER of the FLOSCULOUS FLOWER.

CALYX: The common calyx is a perianthium, which contains the florets and the receptacle. It is either *simple*, *augmented*, or *imbricated*. It contracts when the flowers are fallen, but expands and turns back when the seeds are ripe.

RECEPTACLE: The common receptacle of the fructification receives many sessile florets on its disk, which is either *concave*, *plain*, *convex*, *pyramidal*, or *globular*. The surface of the disk is either *naked*, without any other inequality than that of being lightly dotted; *villous*, covered with upright hairs; or *pallaceous*, covered with paleæ, chaffs, or straws, that are linear, subulate, compressed, and erect, and serve to part the florets.

The structure of the florets which compose a compound flower, will be best understood by pulling to pieces the flower of a thistle, of dandelion, or of the sun-flower, and comparing the florets with the following natural

CHARACTER of the FLORET.

CALYX: A small perianthium, supporting the hermaphrodite floret, often quinquepartite, seated on the germen, persisting, and afterwards becoming the crown of the seed.

COROLLA: Monopetalous, with a long and very narrow tube. It is seated on the germen, and is either *tubulate*, with the limb campanulate and quinquefid, and laciniae spreading and turning back; *ligulate*, with the limb linear, plane, turned outwards, and the top whole; *tridentate*, or *quinquedentate*, or *wanting*, having no limb, and often no tube.

STAMINA: The filaments five, capillary, very short, inserted in the neck of the corollulæ. The antheræ five, linear, erect, and by the union of their sides forming a cylinder that is tubulate, quinquedentate, and of the length of the limb.

PISTILLUM: the germen oblong, placed under the receptacle of the flower; the style filiform, erect, of the length of the stamina, and perforating the cylinder of the antheræ; the stigma bipartite, the laciniae revolute and spreading asunder.

PERICARPIUM: No true one, though in some there is a coriaceous crust.

SEED: A single one, oblong, often tetragonous, but commonly narrower at the base. It is either crowned, or with the crown wanting. The crown is of two kinds, either a pappus or a perianthium; if a pappus, it is either sessile, or placed on a stipes: and consists of many radii, that are placed in a round figure; and are either simple, radiate, or ramous; when the crown is a perianthium, it is such as is described above. The disposition of the stamina and pistillum frequently varying, occasion the following distinctions in the florets, viz. *Hermaphrodite*, containing both stamina and pistilla: *male*, containing stamina, but no pistillum; *female*, containing pistilla, but no stamen; or, *neuter*, containing neither stamina nor pistillum. The essence of a flosculous flower consists in having the antheræ united in a cylinder, and a single seed below the receptacle of the floret. The plants of this class are supposed to have various specific virtues. Most of them are bitter; none are poisonous, except perhaps the *lactuca virosa*, a species
of

of lettuce, when growing in shady situations. The elasticity of the calyx in the ox-tongue, thistle, and many other genera, is too remarkable to pass unnoticed by the slightest observer. It seems as if the expansion of the florets first burst the calyx open, and when these wither, it closes again. The downy hairs that crown the seeds, before upright, now begin to expand, and, by this expansion, again open the leaves of the calyx, and bend them quite back. The seeds now escape, and the calyx, becoming dry and withered, no longer retains its elastic power. The hairy or downy appendages of the seeds, occasion them to be wafted about in the air, and disseminated far and wide. The structure of this down deserves our admiration: there is hardly a child that is insensible to its beauty in the dandelion. The order into which the genera of this class are divided, are as follow:

Order 1. *POLYGAMIA ÆQUALIS*, comprehending such plants as have compound flowers, of which the florets are all hermaphrodite. This order contains forty-two genera, distinguished into, 1. Such as have ligulate compound flowers, of which there are nineteen, viz. *Geropogon*, old man's beard; *Tragopogon*, goat's beard; *Scorzonera*, viper-grass; *Pictis*, ox-tongue; *Sonchus*, sow-thistle; *Lactuca*, lettuce; *Chondrilla*, gum-succory; *Prenanthes*, wild lettuce; *Leontodon*, dandelion; *Hieracium*, hawkweed; *Crepis*, base hawkweed; *Andryala*, downy sow-thistle; *Hioferis*, yellow eye; *Seriola*; *Hypochaeris*, goose-more-hawkweed, or cat's-ears; *Lapsana*, nipple-wort; *Catananche*, *Candia* lion's foot; *Cichorium*, succory or endive; and *Scholymus*, golden-thistle. 2. Such as have tubulous compound flowers; of which there are twenty-three, viz. *Arctium*, burdock; *Serratula*, saw-wort, or way-thistle; *Carduus*, thistle; *Cnicus*, blessed thistle; *Onopordon*, woolly or cotton thistle; *Cynara*, artichoke; *Carlina*, carline-thistle; *Carthamus*, base saffron; *Bidens*, water-hemp agrimony; *Cacalia*, Alpine colt's foot; *Attractylis*, distaff-thistle;

Eupatorium, hemp-agrimony ; Ageratum, base hemp-agrimony ; Ethulia ; Stæhelina ; Chrysocoma, goldylocks ; Calea, halbert-weed ; Tarconanthus, shrubby African fleabane ; Pteronia ; Athanasia, Spilanthus ; Santolina, lavender-cotton ; and Barnadesia.

Order 2. POLYGAMIA SUPERFLUA, comprehending such plants as have the florets of the disk hermaphrodite, and those of the radius *female*. This order contains thirty-eight genera, distinguished into, 1. Tubulous ; of which there are eight, viz. Tanacetum, tansy ; Artemisia, wormwood, or mugwort ; Gnaphalium, everlasting flower, or cudweed ; Xeranthemum, Austrian sneezewort, or eternal flower ; Carpesium ; Baccharis, plowman's spikenard ; Cotula, May-weed ; and Conyza, greater fleabane. 2. Radiate ; of which there are thirty, viz. Erigeron, lesser fleabane ; Tussilago, coltsfoot ; Senecio, groundsel, or rag-wort ; Aster, star-wort ; Solidago, golden rod ; Inula, elacampane ; Cineraria, sky-flower ; Arnica, mountain leopard's bane ; Doronicum, leopard's bane ; Perdicium ; Helenium, base sun-flower ; Bellis, daisy ; Leysera ; Tagetes, African marygold ; Pectis ; Chrysanthemum, corn-marygold ; Matricaria, feverfew ; Anacyclus ; Anthemis, chamomile ; Achillea, millfoil or yarrow ; Tridax, trailing star-wort of Vera Cruz ; Zinnia ; Verbescina, Indian hemp-agrimony ; Sigesbeckia ; Buphtalmum, ox-eye ; Eclipta ; Bellium, base daisy ; Amellus, star-flower ; Unxia ; and Mutisia.

Order 3. POLYGAMIA FRUSTRANEA, comprehending such plants as have the florets of the disk hermaphrodite, and those of the radius *neuter*. This order contains nine genera, all radiate, viz. Helianthus, sun-flower ; Rudbeckia, American dwarf-sun-flower ; Coreopsis, tick-seeded sun-flower ; Gorteria ; Osmites ; Zoegea ; Centaurea, centaury ; Sclerocarpus ; and Didelta.

Order 4. POLYGAMIA NECESSARIA, comprehending such plants as have the flowers of the disk male,
and

and those of the radius female. This order contains fourteen genera, most of which are radiate, viz. *Mil-leria*; *Silphium*, base *chrysanthemum*; *Chrysogo-num*; *Melampodium*; *Calendula*, *marygold*; *Ar-cotis*; *Osteospermum*, hard-seeded *chrysanthemum*; *Othonna*, African ragwort; *Polymnia*, dwarf sun-flower; *Erycephalus*; *Filago*, cotton or cud-weed; *Micropus*, base *cudweed*; *Balimora*; and *Hippia*, shrubby *tansey*.

Order 5. POLYGAMIA SEGREGATA. This order comprehends such plants as have many partial cups contained in the common calyx, which separate and surround the flosculus. This order contains seven genera, distinguished into, 1. Such as have four flosculi in each partial calyx; of which there are two genera, viz. *Elephantopus*, elephant's foot; and *Oe-dera*. 2. Such as have many flosculi in each partial calyx; of which there is only one genus, viz. *Sphæ-ranthus*, globe-flower. 3. Such as have one floscu-lus in each partial calyx; of which there are three genera, viz. *Echinops*, globe-thistle; *Gundelia*; and *Stoebe*, base *Ethiopian elychrifum*. 4. Such as have three flosculi in each partial cup, of which there is only one genus, viz. *Jungia*.

Order 6. MONOGAMIA, comprehending such plants as have simple flowers. This order contains seven genera, viz. *Strumfia*, *Seripium*; *Corymbium*; *Jasione*, sheep's scabious; *Lobelia*, cardinal flower; *Viola*, violet; and *Impatiens*, balsam, or female bal-samine. The genera of this last order are now re-moved into the class *Pentandria*, order *Monogynia*: by which this class is made truly natural.

EXAMPLES for INVESTIGATION.

To enable the reader to form a more perfect com-prehension of the structure of a compound flower, we shall select two examples from among the flowers of this class. The first is the *Helianthus*, or sun-flower, belonging to the order *Polygamia frustranea*, which

which will afford a very clear demonstration of the radiated species. CALYX, Plate XIII. fig. 5; common, imbricate, expanded; the scales or leaflets oblong, acuminate, broadish at the base, the apices or tips dehiscent, gaping or bending outwards. COROLLA, fig. 6; the *compound* corolla radiate; its corollulæ are either those of the hermaphrodite floscules, very numerous, and placed in the disk, marked *a*; or those of the neutral floscules, less numerous, but much larger, and placed in the radius or circumference, marked *b*. The *proper* corolla of hermaphrodite floscules, cylindraceous, shorter than the calyx, ventricose, or swelling at the base, orbiculate, depressed; the limb quinqueidentate, acute, patent. One of these *hermaphrodite* floscules, taken out of the interior border or corolla, and magnified, is represented at fig. 7. The *neutral* floscules ligulate, i. e. tongue or strap shaped, lanceolate, entire, very long: one of these *neutral* floscules, taken from the radius or external border, is shown at fig. 8, magnified. STAMINA, marked *s*, fig. 7; the filaments of the hermaphrodites five, curved, inserted below the ventricose part of the corollula: the length of the tube. PISTILLUM, *p*, fig. 7; in the hermaphrodites, germen *g*, oblong: style filiform, length of the corollula; stigma bipartite, reflex. In the neuter floscule, fig. 8. the germen *g*, very small; style and stigma, none. In fig. 7, *d* shows the perianthium of the hermaphrodite floscule or corollet, which afterwards becomes the pappus of the seed; and *e* shows the quinqueidentate limb of the floscule. PERICARPIUM, none; the dry calyx, fig. 9, supplying its place. SEEDS, fig. 10; in the hermaphrodites solitary, i. e. one to each floscule, oblong, obtuse, tetragonous, at the opposite angles compressed, narrow at the lower part, crowned with a pappus, or two lanceolate aristæ or chaffs, acute, deciduous. The neutral floscules have a germen, but no seeds.

We

We have chosen, for the second example, the Echinops, or globe-thistle, which belongs to the order Polygamia segregata; and this appears the best calculated for our purpose, because it illustrates the character of the globular receptacle, and the single floret, described in p. 85. CALYX, fig. 11; common, polyphyllous, the scales subulate, entirely reflected; becoming full of single florets, as at fig. 12; the *partial* perianthium, *a*, fig. 13; uniflorous, oblong, imbricate, angular; the leaflets, *b*, subulate, lax on the upper part, erect, ciliate, permanent. COROLLA, *c*, fig. 12; monopetalous, the length of the calyx, tubular, the limb or border five-cleft, reflex and spreading, *c*, fig. 13, greatly magnified. STAMINA, *s*, fig. 13; the filaments five, capillary, very short; antheræ cylindraceous, tubulated, with five teeth. PISTILLUM, *p*; the germen, *g*, oblong; style filiform, the length of the corolla; stigma double, somewhat depressed, revolute. PERICARPIMUM, none; the dry calyx, fig. 14, unchanged, supplying its place. RECEPTACLE, *d*, fig. 15; common, globular, beset with bristly chaff. SEEDS: solitary, *e*, fig. 15; ovate, oblong, narrow at the base, apex obtuse, down obscure.

CLASS XX. GYNANDRIA.

This class is one of those which has been lately abolished. It consists of such plants as have the stamina growing either upon the style itself, or upon a receptacle that stretches out into the form of a style, and supports both the stamina and the pistillum. The flowers are by some writers termed *monstrous*, in consequence of this peculiar structure of their parts. The orders are nine, which we shall particularize: but it is first necessary to explain the order Diandria. The flowers of this order have a very peculiar structure, answering to the following description:

CHARACTER

CHARACTER of the Order DIANDRIA, Class GYNANDRIA.

The germen is always contort: the petals are five; of which the two inner ones usually approach and form a galea; the lower lip of which becomes a nectarium, and serves also for a pistillum and sixth petal. The style grows to the inner margin of the nectarium, in such a manner as to be with its stigma scarce either of them distinguishable. The filaments are always two, supporting as many antheræ, which are narrower downwards, naked, or without tunic, and divisible, like the pulp of a citrus. These last are covered by little cells, that are open underneath, and grow to the inner margin itself of the nectarium. The fruit is a capsule, unilocular, trivalved, and splits in the angles under the carinate ribs. The seeds are scobiform, numerous, affixed to a linear receptacle in each valvule. The orders in this class are as follow:

Order 1. DIANDRIA, comprehending such plants as have two stamina. This order contains eleven genera, viz. *Orchis*, butterfly-flower; *Satyrion*, lizard-flower; *Ophrys*, bee-flower, bird's-nest, or tway-blade; *Serapias*, helleborine; *Limodorum*, base hellebore; *Arethusa*; *Cypripedium*, ladies' slipper; *Epidendrum*, vanilla or vanelloe; *Gunnera*; *Forsteria*; and *Disa*. In the new arrangement these genera are placed under the class Diandria.

Order 2. TRIANDRIA, comprehending such plants as have three stamina. This order contains three genera, viz. *Sisyrinchium*, bermudiana; *Ferraria*; and *Salacia*. These genera are removed into the class Triandria.

Order 3. TETRANDRIA, comprehending such plants as have four stamina. Of this order there is but one genus, viz. *Nepenthus*; now placed in the class Tetrandria.

Order 4. PENTANDRIA, comprehending such plants as have five stamina. This order contains
three

three genera, viz. *Passiflora*, passion-flower; *Gluta*; *Ayena*. These are removed to the class *Pentandria*.

Order 5. *HEXANDRIA*, comprehending such plants as have six stamina. This order contains two genera, viz. *Aristolochia*, birthwort; and *Pistia*, water-houseleek; both placed in the class *Hexandria*.

Order 6. *OCTANDRIA*, comprehending such plants as have eight stamina. Of this order there is only one genus, viz. *Scopolia*; now in the class *Pentandria*.

Order 7. *DECANDRIA*, comprehending such plants as have ten stamina. Of this order there are but two genera, viz. *Helicteres*, screw-tree; and *Kleinovia*; both removed into the class *Decandria*.

Order 8. *DODECANDRIA*, comprehending such plants as have twelve stamina. This order contains but one genus, viz. *Citinus*, hypocistis, now in the class *Dodecandria*.

Order 9. *POLYANDRIA*, comprehending such plants as have many stamina. This order contains eight genera, viz. *Grewia*; *Xylopi*a, bitter-wood; *Arum*, wake robin, or cuckoo pint; *Dracontium*, dragons; *Calla*, Ethiopian arum; *Pothos*, scunk-weed; *Ambrosinia*; and *Zostera*, grass-wrack. *Pothos* is removed into the class *Pentandria*; *Dracontium* into the class *Heptandria*; and the other six genera are placed in the class *Polyandria*.

EXAMPLE FOR INVESTIGATION.

The flower chosen to illustrate the characters of the genera in this class, is the broad-leaved *Orchis*, or butterfly-flower, belonging to the first order; which affords a very clear and curious demonstration of the parts of fructification. *CALYX*, fig. 16; a spatha, *a*, indeterminately placed; the spadix, *b*, simple. *PERIANTHIUM*, none. *COROLLA*, fig. 17; the petals five, three exterior, and two interior, which form a galea or helmet, marked *c*. *NECTARIUM*, marked

n, monophyllous, within the insertion of the petals, fixed to the receptacle *d*, fig. 17; the upper lip, *e*, fig. 18, erect, very short, the under lip, *f*, large, patent, broad, descending in a coriiform or horn-shaped tube, marked *h*. STAMINA, *s*; the filaments two, very slender, very short, fixed on the pistillum; antheræ obovate, erect, covered by the duplicate bilocular upper lip of the nectarium. PISTILLUM, *p*; the germen, *g*, oblong, twisted, standing under the flower; style, fixed to the upper lip of the nectarium, very short; stigma compressed, obtuse. PERICARPUM, fig. 19, and 20; a capsule oblong, unilocular, having three keels, as shown at *i*, fig. 19; trivalvular, opening under the carinas, in three divisions, adhering together at the base and the apex, as in fig. 20. SEEDS, numerous, very small, like saw-dust; as shown at *k*, fig. 19.

CLASS XXI. MONOECIA.

This class, which is now also abolished, was framed by Linnæus to comprehend all such plants as have no hermaphrodite flowers, but such only as are androgynous, bearing both male and female flowers on the same plant. The orders are eleven, viz.

Order 1. MONANDRIA, comprehending such plants as have their male flowers furnished with one stamen. This order contains ten genera, viz. Zannichellia, triple-headed pond-weed; Ceratocarpus; Cynomorium; Elaterium, spring-gourd; Chara; Egopricon; Artocarpus, bread-fruit-tree, Nipa; Caluarina; and Phyllachne. These genera, in the new arrangement, are placed in the class Monandria.

Order 2. DIANDRIA, comprehending such plants as have their male flowers furnished with two stamina. This order contains two genera, viz. Lemna, duck-meat; and Anguria; both of which are removed to the class Diandria.

Order 3. TRIANDRIA, comprehending such plants

as

as have their male flowers furnished with three stamina. This order contains twelve genera, viz. *Omphalea*; *Typha*, cat's-tail, or reed-mace; *Sparganium*, burr-reed; *Zea*, Indian or Turkey wheat; *Coix*, Job's tears; *Tripsacum*; *Olyra*; *Carex*, sedge, or cyperus grass; *Axyris*; *Tragia*; *Hernandia*, jack-in-a-box; and *Phyllanthus*, sea-side laurel. These genera are now removed into the class *Triandria*, except the genus *Omphalea*, which is placed in the class *Diandria*.

Order 4. *TETRANDRIA*, comprehending such plants as have their male flowers furnished with four stamina. This order contains eight genera, viz. *Betula*, birch-tree; *Buxus*, box-tree; *Urtica*, nettle; *Morus*, mulberry-tree; *Cicca*; *Serpicula*; *Littorella*; and *Aucuba*. These are now placed under the class *Tetrandria*.

Order 5. *PENTANDRIA*, comprehending such plants as have the male flowers furnished with five stamina. This order contains eight genera, viz. *Xanthium*, lesser burdock; *Ambrosia*; *Parthenium*, base-feverfew; *Iva*, false Jesuits' bark-tree; *Léca*; *Amaranthus*, amaranth, or flower gentle; *Nepheium*; and *Clibadium*. These genera are all carried into the class *Pentandria*, except the genus *Amaranthus*, which is placed in the class *Triandria*.

Order 6. *HEXANDRIA*, comprehending such plants as have their male flowers furnished with six stamina. Of this order there are two genera, viz. *Zizania*, water-oats, or tare-grass; and *Pharus*; both which are removed into the class *Hexandria*.

Order 7. *HEPTANDRIA*, comprehending such plants as have their male flowers furnished with seven stamina. Of this order there is but one genus, viz. *Guettardo*; now placed in the class *Hexandria*.

Order 8. *POLYANDRIA*, comprehending such plants as have their male flowers furnished with many stamina. This order contains thirteen genera, viz. *Ceratophyllum*, horn-wort; *Theligonum*, dogs-cabbage;

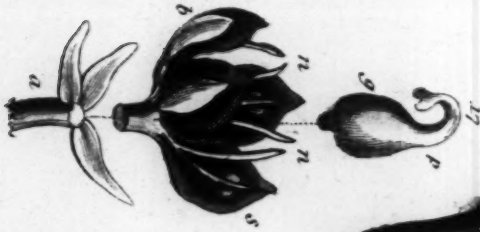
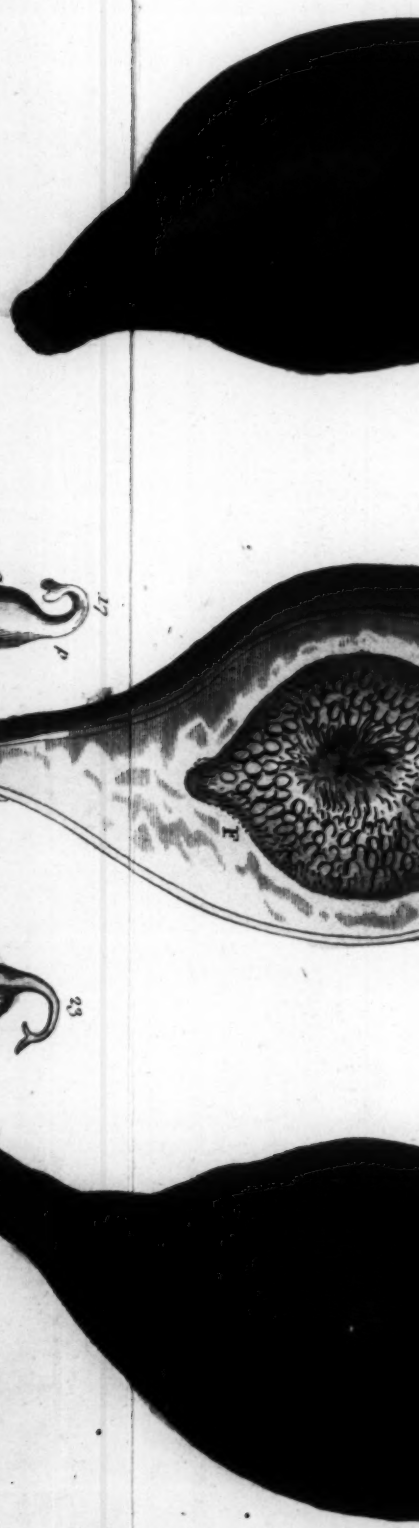
bage; Juglans, walnut-tree; Fagus, beech-tree; and Carpinus, hornbeam: these five are removed into the class Dodecandria. Corylus, hazel or nut-tree; Quercus, oak-tree; and Myriophyllum, water-milfoil: these three are carried into the class Oclandria. Platanus, plane-tree; Liquidambar, sweet-gum; Poterium, garden burnet; Sagittaria, arrow-head; and Begonia: which five are removed into the class Polyandria.

Order 9. MONADELPHIA, comprehending such plants as have their male flowers furnished with one set of united stamina. This order contains fifteen genera, viz. Hura, sandbox-tree; Pinus, pine-tree; Cupressus, cypress; Thuja, arbor vitæ; Acalypha; Dalechampia; Plucknetia; Cupania; Croton, tallow-tree, or bale ricinus; Ricinus, palma-christi; Iatropha, cassava, or manihot; Sterculia; Hippomane, marchineel; Stillingia; and Gnetum. These plants are now carried into the class Monadelphia, except Hura, which is placed in the class Enneandria; and Cupania, which is removed to the class Oclandria.

Order 10. SYNGENESIA, comprehending such plants as have their male flowers furnished with stamina of which the antheræ are united. This order contains six genera, viz. Tricosanthes, serpent-cucumber; Momordica, male balsam-apple; Cucumis, cucumber; Cucurbita, gourd; Sicyos, single-seeded cucumber; and Bryonia, briony. These genera are removed into the class Triandria.

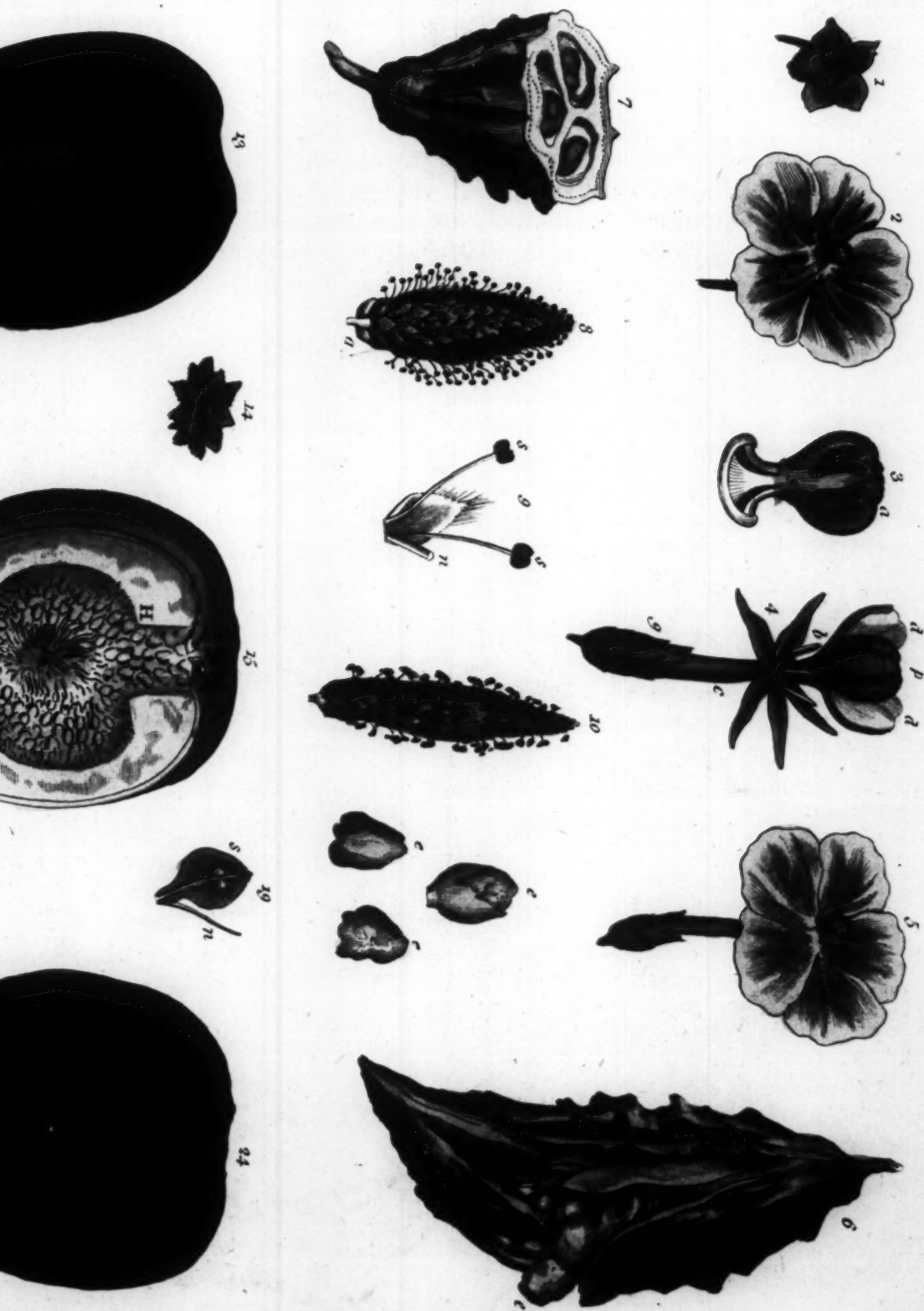
Order 11. GYNANDRIA, comprehending such plants as have their male flowers furnished with stamina that grow out of a kind of style, or imperfect pistillum, the perfect one being in the female flower. This order contains two genera, viz. Andrachne, base orpine; and Agyneia: the first of which is removed into the class Pentandria; and the latter into the class Triandria.

EXAMPLE



Genera of Plants. — No. 4.

London: Published as the Act directs. Aug²⁹. 1729. By E. MILLAR.



EXAMPLE FOR INVESTIGATION.

Though this is one of the classes lately abolished, we shall nevertheless investigate one of the genera placed under it by Linnæus, in order to show the *monoecious* character, which induced him to arrange these plants by themselves. We have selected for this purpose the *Momordica*, or male balsam-apple; the fructification in which, being extremely obvious, seems well calculated to afford the necessary information to a learner. CALYX, of the *male flower*, see Botanical Plate XIV. fig. 1; a perianthium monophyllous, concave, quinquefid; the lacinias or segments oblong, spreading. COROLLA, fig. 2; quinquepartite, united with the calyx, more spreading, large, veinous, rugous. STAMINA, *s*, fig. 3; the filaments three, subulate, short; antheræ placed on two filaments, bifid, having ears on both sides at *a*; the third has only an ear on one side, consisting of a compressed body, and a fariniferous lacinia once reflex. This figure represents the stamina taken out of the flower, and greatly magnified. *Female flower, on the same plant.*—CALYX, fig. 4; a perianthium monophyllous, superior, or standing above the germen, quinquepartite, the lacinia or leaflets lanceolate, spreading. COROLLA, fig. 5; quinquepartite as in the male. STAMINA, none; there being three short filaments destitute of antheræ, as shown at *b*, fig. 4. PISTILLUM, *p*, fig. 4; germen, *g*, inferior, or standing below the flower, of a conic form, large; style single, round, like a column, as at *c*, fig. 4; stigmas three, gibbous, oblong, pointing outwards, as at *d*. PERICARPIUM, fig. 6; a pome, dry, oblong, opening with an elastic force to discharge the seeds, trilocular, as at fig. 7; the dissepiments or cells, membranaceous, soft, distant. SEEDS; many, compressed, covered at the base with an exterior scale like a berry, as shown at *e*. The fruit is attenuated at both ends, angular, and tuberculated.

CLASS

CLASS XXII. DIOECIA.

This class, by the modern arrangement, is also abolished. Linnæus placed under it the whole of those plants which have no hermaphrodite flowers, but that bear male and female flowers on different or distinct plants: these he divided into the fifteen orders following.

Order 1. **MONANDRIA**, comprehending such plants as have their male flowers furnished with one stamen. This order contains only three genera, viz. *Dombeya*, removed into the class Monadelphia; *Najas*; and *Pandanus*, screw-pine; removed under Monandria Monogynia.

Order 2. **DIANDRIA**, comprehending such plants as have their male flowers furnished with two stamens. This order contains three genera, viz. *Vallisneria*; *Salix*, willow; and *Cecropia*, trumpet-tree. These genera are removed into the class Diandria.

Order 3. **TRIANDRIA**, comprehending such plants as have their male flowers furnished with three stamens. This order contains six genera, viz. *Empetrum*, black-berried heath, or crow-berries; *Osyris*, poet's cassia; *Caturus*; *Excœcaria*, aloes-wood; *Resilio*; and *Maba*.—Removed into the class Triandria.

Order 4. **TETRANDRIA**, comprehending such plants as have their male flowers furnished with four stamens. This order contains seven genera, viz. *Viscum*, mistletoe; *Hippophæ*, sea buckthorn; *Myrica*, candleberry-myrtle, gale, or sweet willow; *Trophis*; *Batis*; *Montinia*; and *Brucea*.—*Hippophæ* is removed into the class Pentandria; all the other genera into the class Tetrandria.

Order 5. **PENTANDRIA**, comprehending such plants as have their male flowers furnished with five stamens. This order contains twelve genera, viz. *Pistacia*, pistacia-nut; *Zanthoxylum*, tooth-ach tree; *Astronium*; *Irefine*; *Anudesma*, Chinese laurel; *Spinacia*,

Spinacia, spinage; *Acnida*, Virginian hemp; *Cannabis*, hemp; *Humulus*, hop; *Zanonia*; *Feuillea*; and *Canarium*. The genera of this order are all removed into the class *Pentandria*.

Order 6. *HEXANDRIA*, comprehending such plants as have their male flowers furnished with six stamina. This order contains four genera, viz. *Tamus*, black briony; *Smilax*, rough bindweed; *Rajania*; and *Dioscorea*, Indian yam. These genera are removed into the class *Hexandria*.

Order 7. *OCTANDRIA*, comprehending such plants as have their male flowers furnished with eight stamina. This order contains three genera, viz. *Populus*, poplar-tree; *Rhodiola*, rose-root; and *Margaritaria*. The plants in this order are removed into the class *Octandria*.

Order 8. *ENNEANDRIA*, comprehending such plants as have their male flowers furnished with nine stamina. This order contains two genera, viz. *Mercurialis*, Mercury; and *Hydrocharis*, frog's bit. These are now removed into the class *Enneandria*.

Order 9. *DECANDRIA*, comprehending such plants as have their male flowers furnished with ten stamina. This order contains four genera, viz. *Carica*, papaw-tree; *Kiggelaria*; *Coriaria*, myrtle-leaved sumach; and *Schinus*, Indian mastich-tree. These genera are now placed in the class *Decandria*.

Order 10. *DODECANDRIA*, comprehending such plants as have their male flowers furnished with twelve stamina. This order contains three genera, viz. *Menispermum*, moon-seed; *Datisca*, base hemp; and *Euclea*. These are removed into the class *Dodecandria*.

Order 11. *ICOSANDRIA*, comprehending such plants as have their male flowers furnished with many stamina inserted into the calyx. Of this order there is but one genus, viz. *Flacourtia*; which is now placed in the class *Polyandria*.

Order

Order 12. **POLYANDRIA**, comprehending such plants as have their male flowers furnished with many stamina. Of this order there are two genera, viz. *Cliffortia*, and *Hedycaria*; now also removed into the class *Polyandria*.

Order 13. **MONADELPHIA**, comprehending such plants as have their male flowers furnished with one set of united stamina. This order contains six genera, viz. *Taxus*, yew-tree; *Juniperus*, juniper; *Ephedra*, shrubby horse-tail; *Cissampelos*; *Napæa*; and *Adelia*. These plants are now arranged in the class *Monadelphia*.

Order 14. **SYNGENESIA**, comprehending such plants as have their male flowers furnished with stamina of which the antheræ are united. Of this order there are but two genera, viz. *Ruscus*, knee-holly; or butchers'-broom; and *Myrsinica*, the nutmeg-tree. This last genus is now removed into the class *Monandria*, order *Monogynia*; and *Ruscus* is placed in the class *Triandria*, order *Monogynia*.

Order 15. **GYNANDRIA**, comprehending such plants as have their male flowers furnished with stamina that grow out of a kind of style, or imperfect pistillum, the perfect one being in the female flower. Of this order there is but one genus, viz. *Cluytia*; now removed into the class *Pentandria*, order *Trigynia*.

EXAMPLE for INVESTIGATION.

Notwithstanding this class is abolished by the later botanists, it is nevertheless necessary for the learner to be acquainted with the *dioecious character*, to what part soever of the system the plants may be removed. We shall therefore investigate in this place a very common and well-known plant from the second order of this class, viz. the *Salix*, or willow, which bears the male and female flowers upon an amentum or catkin on *different* trees; but so exceedingly minute,
that

that we cannot delineate their parts without the aid of a magnifier. CALYX, Plate XIV. fig. 8: the amentum of the *male tree*; oblong, imbricate, with an involucre formed of the germ, at *a*; the whole amentum charged with squamæ or scales, each forming one flower; the scale or leaflet oblong, plain, patent, villous or hairy: one of these flowers, taken from the catkin and magnified, is shown at fig. 9. COROLLA: none. NECTARIUM: a cylindraceous gland, very minute, truncate, melliferous, adhering to the base of the squama, at *n*, fig. 9. STAMINA, *ss*: the filaments two, filiform, erect, longer than the calyx; antheræ twin, or double. Fig. 10, an amentum taken from the *female tree*, beset with squamæ, the same as in the male. COROLLA: none. Fig. 11, one of the squamæ or flowers taken from the female amentum, and magnified. PISTILLUM, *p*; the germen, *g*, ovate, attenuated into a cylindraceous style, not very distant, a little longer than the leaflet or scale of the flower; the stigmas two, bifid, revolute. PERICARPium, fig. 12; a capsule, ovate and subulate, formed of the germen, unilocular, bivalve, the valves revolute. SEEDS: many, ovate, very small, crowned with a simple hairy pappus, as at *b*.

CLASS XXIII. POLYGAMIA.

Under this head Linnæus arranged all such plants as are found to bear hermaphrodite flowers, and also male or female flowers, or *both*, either on the *same* or on different plants. And though, in the system of later botanists, this class is abolished, it is still requisite for the learner to investigate the orders as originally formed by Linnæus, that he might with more facility detect the genera in the different classes under which they are now placed. The orders of the Polygamia class are therefore as follow, viz.

Order 1. MONOECIA, comprehending such genera as have the polygamy on the same plant. This

order contains twenty-four genera, distinguished into,
 1. Such as are polygamous by male hermaphrodites and female hermaphrodites; of which there is but one genus, viz. *Musa*, plantain-tree; now placed in the class *Hexandria*, order *Monogynia*. 2. By hermaphrodites and males; of which there are twenty-two, viz. *Ophioxylum*; *Celtis*, lote, or nettle-tree; these are removed into the class *Pentandria*. *Veratrum*, white hellebore; now in the class *Hexandria*. *Fusanus*; now in the class *Tetrandria*. *Andropogon*, beard-grass; *Holcus*, Indian millet; *Apluda*; *Ischæmum*; *Cenchrus*, hedgehog-grass; *Ægilops*, hard grass; *Spinifex*; and *Manisuris*; all which are removed into the class *Triandria*. *Valantia*, crosswort; *Brobejum*, African almond-tree; *Parietaria*, pellitory; now carried into the class *Tetrandria*. *Hermas*; *Atriplex*, orache, or sea-purslane-tree; now in the class *Pentandria*. *Acer*, maple-tree; removed to the class *Octandria*. *Gouania*, chaw-stick; and *Solandra*; now placed in the class *Pentandria*. *Terminalia*, benzoin; removed to the class *Decandria*. *Clusia*, balsam-tree; removed to the class *Polyandria*.
 3. By hermaphrodites and females; of which there is one genus, viz. *Mimosa*, sensitive-plant; now in the class *Polyandria*.

Order 2. *DIOECIA*, comprehending such plants as have the polygamy on two distinct plants. This order contains ten genera, distinguished into, 1. Such as are polygamous by hermaphrodites and females; of which there are two, viz. *Fraxinus*, ash tree; now in the class *Diandria*; and *Gleditschia*, three-thorned acacia; now in the class *Hexandria*. 2. By hermaphrodites and males; of which there are three, viz. *Diospyrus*, Indian date-plum; now placed in the class *Octandria*; *Nyssa*, tupelo-tree; and *Pisonia*, fingrido; both removed to the class *Pentandria*. 3. By androgynes and males; of which there are five, viz. *Anthospermum*, amber-tree; and *Stilbe*; both now placed

placed in the class Tetrandria. *Arctopus*; and *Panax*, ginseng; both removed to the class Pentandria; and *Chrysitrix*; now in the class Polyandria.

Order 3. *TRIOECIA*, comprehending such genera as have the polygamy on three distinct plants. This order contains two genera, viz. *Ficus*; the fig-tree; now removed into the class Triandria: and *Ceratonia*, the carob-tree, or St. John's bread; now in the class Pentandria.

EXAMPLE FOR INVESTIGATION.

That the learner may at once acquire a competent idea of the singular structure of the fructification in the *Ficus*, or fig, we have chosen that plant for the illustration of the genera in the third order of this class. The fruit of the *ficus* is not a pericarpium, but a receptacle, the interior sides of which support the flowers, which by this means are inclosed within it. These flowers in the cultivated fig-trees are female only; but there is a species, known by the name of *Caprificus*; that has male flowers; and another again, called *Erinosyce*, which is androgynous, having both male and female flowers distinct, though lodged within the same receptacle. There is also an instance given by M. de la Hire, of a receptacle containing hermaphrodites only; and another by Mr. John Miller, with hermaphrodite and female flowers in the same receptacle; the delineation of which we shall give in this place from the latter author. The parts are as follow: *CALYX*, fig. 13, common, very large, obovate, fleshy, concave, shut up with many squamæ or scales, semi-lanceolate, acute, serrated, inflex. A bunch of these scales is shown magnified, at fig. 14. The inner surface is covered with floscules or florets, of which the uppermost approaching the calycine margin, are hermaphrodites, marked H, in the longitudinal section of the calyx, fig. 15, cut open to expose the interior arrangement of the florets. The

hermaphrodite flowers, at H, are but few, and occupy only the upper part; those underneath, quite down to F, are female, and very numerous. One of the *hermaphrodite flowers*, sitting on its peduncle or foot-stalk, taken out of the calyx, and very strongly magnified, is shown at fig. 16, with a floret of the natural size by its side. CALYX of the hermaphrodite flower, marked *a*, fig. 17, a perianthium proper, tripartite, erect; the segments lanceolate, erect, equal. COROLLA, *b*; tetrapetalous, having four petals, oblong-ovate, concave, incumbent, fixed at the base of the stamens. STAMINA, *s*; shown at fig. 17, 18, 19; filaments four, subulate; antheræ two, ovate, testaceous, placed in the middle of each filament. NECTARIUM: formed of four filaments, marked *n*, fig. 17 and 19; subulate, nearly as long as the stamens, standing between every two antheræ, of a white transparent colour. PISTILLUM, *p*; germen, *g*, fig. 16 and 17; the germen oval; style intort; stigma emarginate. PERICARPIUM, fig. 20; none but the calyx of the floret, oblique, containing the seed in the middle. SEEDS: one to each floret, subrotund, compressed, marked *c*.

Female Flower.—CALYX, fig. 21, marked *d*; a perianthium proper, quinquepartite, segments lanceolate, narrow at both ends, straight, somewhat unequal. COROLLA: none. PISTILLUM, *p*; the germen, *g*, oval; style subulate, inflex; stigmas two, acuminate, reflexed, one shorter than the other. Fig. 22, shows the female flower sitting on its peduncle, greatly magnified, and one of the natural size by its side. PERICARPIUM, fig. 23; none but the calyx, as in the hermaphrodite flower. SEEDS, marked *c*, one to each female floret, same as in the hermaphrodites. Fig. 24, the ripe fruit; being a receptacle, the interior sides of which support the flowers and fructification, as shown in fig. 15. This fruit contains all the pericarpia, with their ripe seeds, which fall out at the apex.

The

The best time to examine the fructification, is a little before the maturity of the fruit.

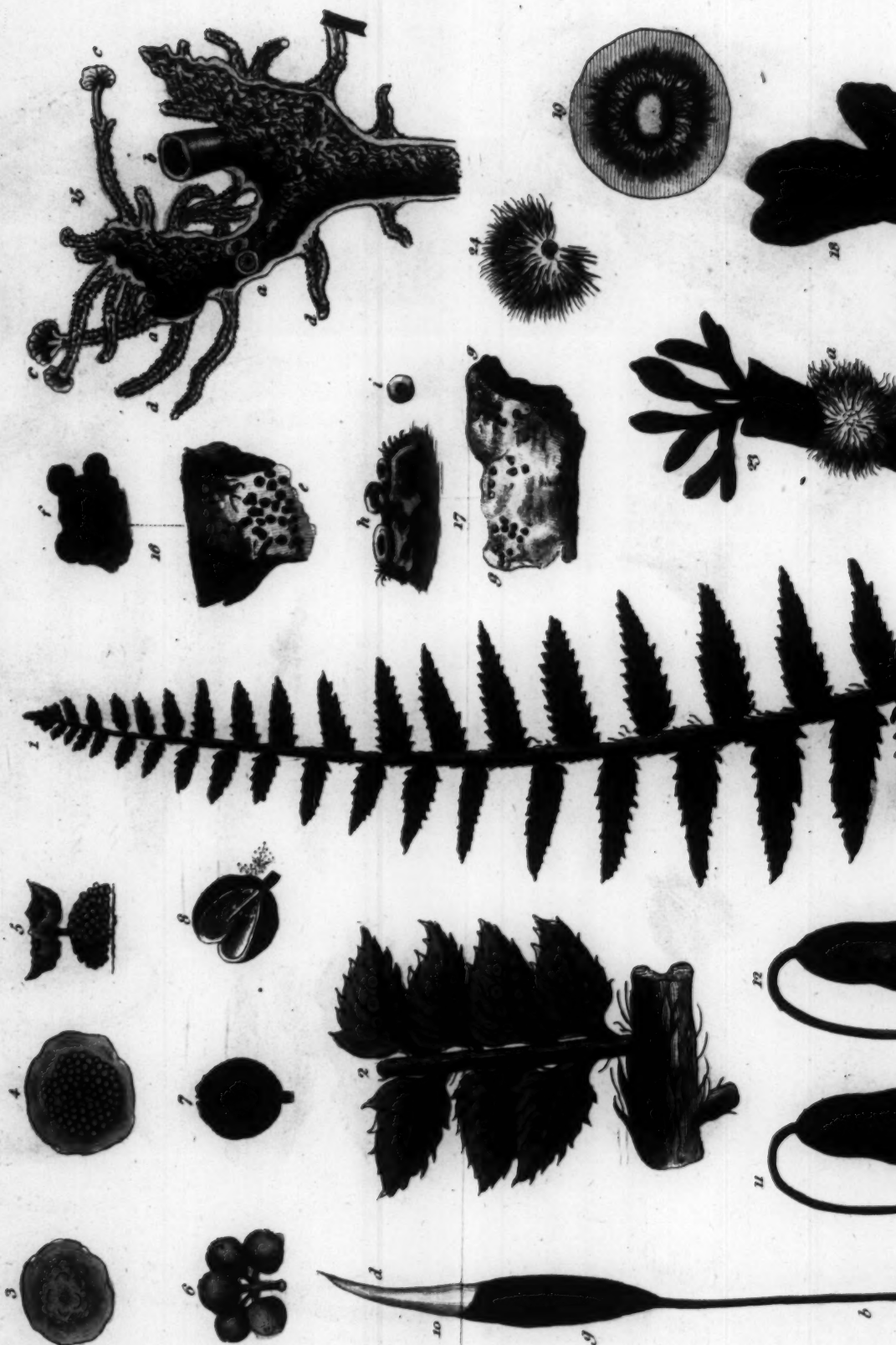
CLASS XXIV. CRYPTOGAMIA.

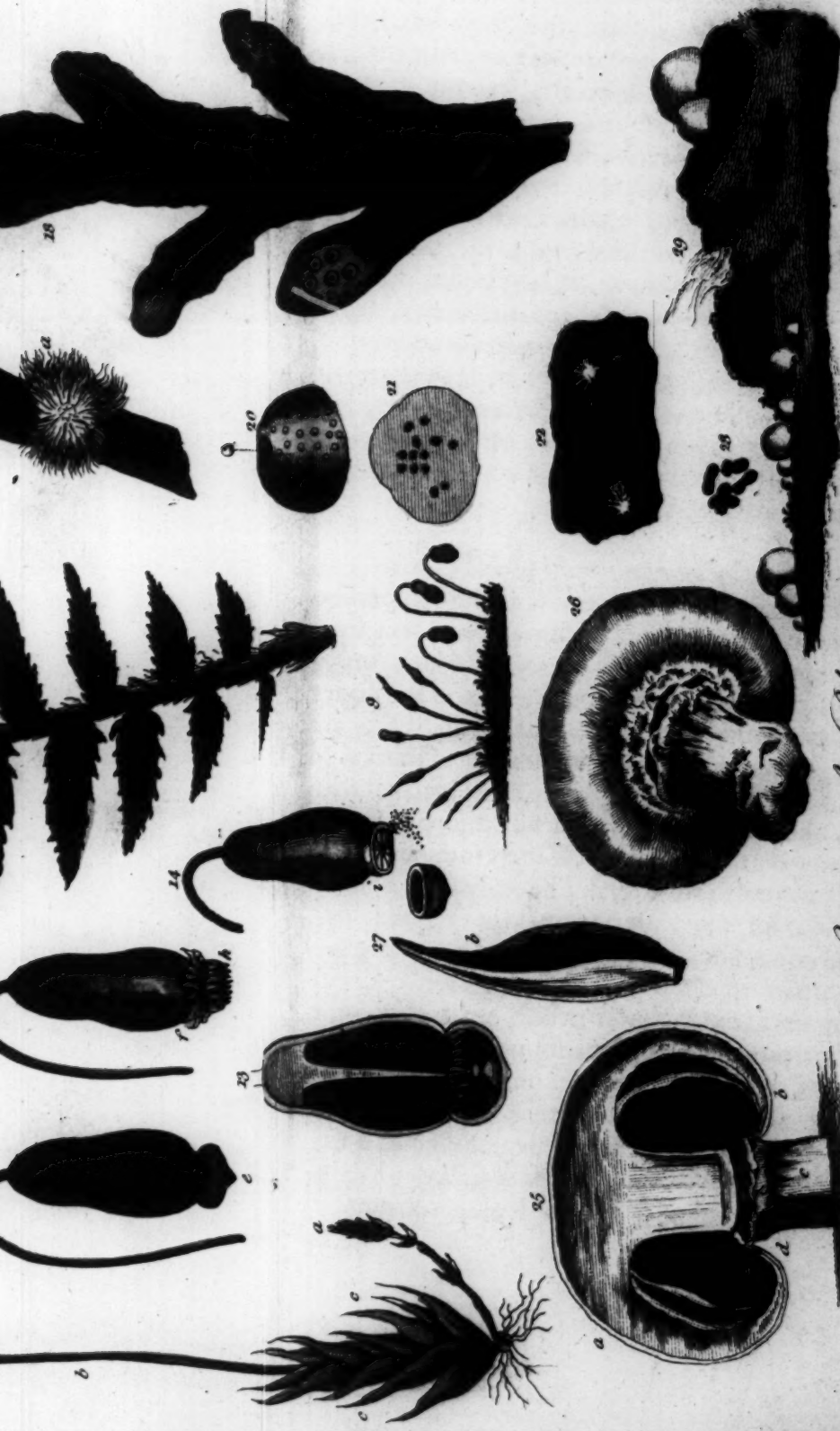
The Cryptogamia class may be considered as containing a number of vegetables whose flowers and fructification are but imperfectly known, and whose stamina and pistillum are too minute easily to admit of that mode of investigation which prevails throughout the preceding classes. The structure too, of these vegetables, differs considerably from that of other plants; from which cause it is probable that the attention of Linnæus was much less bestowed upon the plants of this class, than upon those with more obvious fructifications. It was his glory (says Dr. Withering) to have established a system upon the organs of generation, of all others the most essential parts of a plant; and this system he has wrought up to such a state of perfection, that little, compared to what he himself has done, remains for his successors to do; except the additions it may receive from more extended researches in countries imperfectly or not at all explored before. Of the plants of the Cryptogamia class, he seems chiefly to have improved our knowledge of the Filices. The Musci and the Algæ had been so successfully explored and so excellently figured by Micheli and Dillenius; and Gmelin having done much on the subject of the Fuci; there remained in these extensive tribes, but little more for Linnæus to do, than to distribute and characterise them according to his own ideas. The Fungi, at one time, attracted his attention; but the difficulty of preserving them in a state fit for comparing together, and the impracticability of transporting his books along with himself in his various journeys, seem to have checked his pursuits; neither could he benefit, as we now do, by the almost innumerable figures which have been published since the formation of his system. From these causes he has
done

done but little in the Fungi, and that little has been ill understood. Our countryman, the excellent Ray, paid great attention to these subjects: but for want of figures, or more extended descriptions, it is often difficult, sometimes impossible, to determine his species.—Great improvements, however, in the Cryptogamia class, have been made since the time of Micheli, Dillenius, and Linnæus, by the united labours of Jacquin, Hoffman, Wiegand, Batsch, Pollick, Weis, Ehrhart, Schmidel, Schreber, Dickson, Withering, Stackhouse, Vellay, and especially Hedwig, who first communicated the result of his observations to the Academy of Sciences at Petersburg in 1783. Suffice it here to give an illustration of the orders of this class as framed by Linnæus, which are four, viz. Filices, Musci, Algæ, and Fungi.

ORDER I. FILICES, or FERNS.

The plants that pass under this general denomination, have the fructification essentially different from that of all others, at least in point of situation; being generally disposed either in spots or lines on the under surface of the fronds or leaves; and, as the parts are too minute to be observed without the assistance of very strong magnifiers, the genera are chiefly distinguished by the disposition of the seeds under their covers. The general structure of the fructification in this order is the following. The calyx is a scale, springing out of the inferior surface of the leaf, opening on one side. Under this scale, commonly supported upon little foot-stalks, are *globules* connected together in a round cluster; these burst when ripe, and scatter a powder, which is found to be the seed. This curious mechanism may be observed by the assistance of a good single microscope, with a reflecting speculum, during the months of September and October, in the Polypodiums, Pteris aquilina, or common brakes, and in Asplenium scolopendrium, or hart's-





Genera of Plants - N^o 5.

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hart's-tongue. The powder which is dispersed in this operation is so minute as hardly to be visible to the naked eye. That it is the seed, has been proved by actually raising plants from that of the hart's-tongue, by Morison; and more recently, in the most satisfactory manner, by Mr. John Lindsay, surgeon in Jamaica, from *Polypodium lycopodioides*. Hedwig thinks that he has detected male flowers, or antheræ, either sessile, or else on a very short filament, scattered over the back of the frond, of an ovate or subglobular form. From this singularity of the fructification being on the back or lower side of the leaf, the older botanists named the order in which they ranged the ferns, *Epiphyllispermæ*, and *Dorsiferæ*.

The plants arranged under this order by Linnæus, are as follow: *Cycas*, todda-pana; *Zamia*; *Equisetum*, horse-tail; *Onoclea*, sensible fern; *Ophioglossum*, adder's-tongue; *Osmunda*, flowering-fern; *Acrostichum*, forked fern; *Pteris*, brakes, or female fern; *Blechnum*; *Hemionitis*, mule's fern; *Asplenium*, spleenwort; *Lonchitis*, rough spleenwort; *Polypodium*, polypody; *Adiantum*, maidenhair; *Trichomanes*, Tunbridge maidenhair; *Marsilea*; *Pilularia*, pepper-grass; and *Isoetes*, quill-wort.

EXAMPLE for INVESTIGATION.

The subject we have chosen for the elucidation of the genera in this order, is the species of fern called *Polypodium aculeatum*, or prickly polypody, found in woods and shady places. The first appearance of this plant is a curled leaf or tuft issuing out of the ground, and proceeding upward, until it forms the branch represented in the Botanical Plate XV. fig. 1, which is called a *frond*. The stem or footstalk is called *stipes*, covered with chaffy lanceolate scales and bristles. The frond bipinnate, or doubly winged, (when the leaflets of a pinnate leaf are pinnate;) the pinnæ or little leaflets of the wings are mostly alternate, sessile,

sessile, acute, somewhat prickly, serrate, and ciliate; the lowest serrature extended into a lobe. Fig. 2, represents a portion of the stem or stipes of the frond dissected off, with the base of one of the pinnæ or side-leaves, and its lowermost leaflets, considerably magnified, to show the parts of fructification, which are little round globules of a milky colour, adhering to each side of the midrib, supposed to be *monoecious*. CALYX, fig. 3; a little round scale, greatly magnified; called the *clypeus*, or shield, membranaceous, orbiculate, petalate, covering the fructifications, which consist of a number of minute particles delineated at fig. 4. COROLLA, none. STAMINA: said by Hedwig to have antheræ, distinguishing the male flowers, supported on very small filaments, ovate. PISTILLUM, a globule supported on a pedicle; at the time of flowering orbiculate, tied with a circular fibre, deciduous. After flowering the fibre lacerates, and the membrane recedes into the form of a cup, as shown at fig. 5, covering the capsule, which is an assemblage of globules fasciculated, or tied together on slender footstalks. A little bunch of these globules, taken from fig. 5, is shown at fig. 6, with their footstalks, as they appear under a very strong magnifier. PERICARPIUM, fig. 7; one of these capsular globules, matured, having small tubercles or wrinkles on the apex, where it opens. SEEDS: many, extremely minute, globular; represented at fig. 8, which shows the conceptacle of the seeds.

Since the discoveries made by Hedwig and others, the genera, *Equisetum*, *Marsilea*, *Pilularia*, and *Isoetes*, which stood among the Ferns; together with *Lycopodium* and *Porella*, which were placed in the order of Musci by Linnæus; have been united to form a new order, called MISCELLANEA, which now stands first of the class Cryptogamia, in Linnæus's *Genera Plantarum*, as published by Schreber.

The

The uses of the ferns are as yet but little known. Few of them are esculent. They have a disagreeable heavy smell. In large doses they destroy worms; and some of them are purgative. The ashes produced by a slow incineration of the green plants, contain a considerable portion of vegetable alkali, and are generally sold under the name of ash-balls, to make lye for washing linen. The leaves, if cut down when fully grown, and dried, make a thatch much more durable than straw. South America and the West-India islands furnish abundance of species, many of which grow to a great size, and others are very ornamental plants in hot-houses, where they become evergreens.

ORDER II. MUSCI, or MOSSES.

The tribe of Mosses were formerly considered as mere excrescences produced from old walls, trees, earth, &c. but they are now found to be plants, no less perfect than those of greater magnitude. They are ranged by Linnæus into three divisions, viz. 1. Those whose fructifications are without any calyptra or veil; of which there are three genera: *Lycopodium*, club-moss; *Sphagnum*, bog-moss; and *Porella*. 2. Those which are veiled, or covered with a calyptra, *diclinous*, or having the males and females *separate*; as *Splachnum*, bottle-moss; *Polytrichum*, golden maiden-hair; and *Mnium*. 3. Those which are calyptrated or veiled, but *monoclinous*, having the males and females on the same plant: as *Phascum*; *Bryum*; *Hypnum*; *Fontinalis*, water-moss; and *Buxbaumia*.

According to Hedwig, mosses are vegetables in which the female parts of fructification are furnished with a veil-like petal, bearing a style. He divides them into two orders.

1. FRONDOSI: Capsule entire, lidded, and opening transversely.

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D d

2. HEPA-

2. **HEPATICI**: Capsule with four valves, opening length-ways.

The latter are not ranged with the Musci, but with the Algæ, by Linnæus. These definitions of Hedwig exclude the Lycopodium from the order Musci. The proper mosses, according to Schreber, may be distinguished by the following

NATURAL CHARACTER.

Male flowers.—**CALYX**: common, of many leaves: leaflets in structure resembling those of the plant, but generally broader, sometimes coloured, open and expanding like the rays of a star, or the petals of a full-blown rose, or else closing and approaching like a bud. Some few have no appearance of a calyx.

COROLLA: none.

STAMINA: numerous, within the common calyx, mostly separated by succulent threads or chaff-like substances; sometimes uniting so as to form a little knob, or placed in the axils of the upper branches. Filaments short, filiform. Antheræ sometimes cordate or ovate, but mostly cylindrical, one-celled, opening at the top and discharging granulated pollen.

Female Flowers, on the same or a different plant, sometimes intermixed with the males. **CALYX**: a perianthium many-leaved; leaflets various, generally inclosing several pistils intermixed with succulent threads.

COROLLA: a veil, cylindrical, or conical; investing the germen, and fixed to its top, united at the base to the sheath of the peduncle, but not elsewhere attached.

PISTILLUM: the germen cylindrical or conical; style slender, standing on the veil; stigma truncate.

PERIANTHIUM: a capsule on a peduncle sheathed at the base, when unripe crowned by the veil, which separates at its base, adhering to the point of the

the capsule; but falling off when that becomes ripe. The capsule then opens horizontally, the operculum or lid separating. *Lid* with or without a ring, single; or double; outer cartilaginous, sometimes swollen, or else contracted at the base, forming a kind of excrescence called apophysis. *Mouth* of the capsule either naked, or closed with an outer-fringe. *Outer fringe* with from four to thirty-two teeth, which are upright or reflected, straight or twisted, triangular, spear-shaped or bristle-shaped, acute or blunt. *Inner fringe* finer, either closely adhering to the outer, or joined to it by threads from its inner side, or loose and unconnected, or fixed to the pedicle on its little bulb. *Mouth* naked, or covered with a membrane or network of the inner fringe, or variously jagged, or closed by distinct and regular teeth. *Column* extending from the base to the point of the capsule, filiform, straight, passing through the lid into the style, and often giving the lid a pointed appearance.

SEEDS: Numerous, minute, spherical, smooth or rough.

HABIT: Stems leafy. Leaves membranaceous, reticulated, after being dried reviving when soaked in water.

If *Bryum pomiforme*, *subulatum* of Haller, *trichodes*, and a few others, be excepted, mosses bear the stamens and pistillum in *separate* flowers, either on the *same* or on *distinct* plants. The time of flowering generally coincides with that of the fruit attaining maturity, as happens in other evergreen perennials. Thus in *Polytrichum urnigerum*; *Mnium fontanum*, *hornum*, *punctatum*, *undulatum*; *Bryum trichodes*, *cæspitium*, &c. the veils fall off early in the spring, and the seed is scattered abroad; whilst at the same time the less obvious unimpregnated germens, and the male or stameniferous flowers, are performing their respective functions. This circumstance has hereto-

fore caused these ripe capsules to be mistaken for antheræ, and the seeds for pollen.

Both male and female flowers are furnished with an involucre, which gives the outward figure to the flower, and is called the *perichæatium*, as growing round the foot-stalk. It varies more, and is more to be attended to, in the male than in the female flowers. The radiated disks of the *Polytrichums* and *Mniums* are very remarkable, and the scales composing them differ in many respects from the other leaves. The heads which put forth at the extremities of the *Bryums*, have been hitherto unnoticed, though they contain the parts of fructification, and are composed of leaflets or scales different both in shape and size from the stem-leaves. Thus in *Bryum rurale* they are not terminated by hairs, and are shorter than the stem-leaves. In *Bryum pellucens*, *Scoparium*, *Heteromallum*, *aciculare*, &c. they are broader than the other leaves, and more hollow at the base. Where the disk-like substances form a kind of bud, as in almost all the *Hypnums*, *Bryum extensorium*, *subulatum*, *pulvinatum*, *hypnoideum*, &c. they are much smaller than the leaves; they are also concave, ovate, or spoon-shaped, and destitute of the hairs which are on the real leaves. These therefore are truly the calyx, and as they include the florets with stamens only, they may be called the *perichæatiums* of the male florets.

On those mosses which bear female flowers or capsules, the leaves adjoining to the peduncle are much more beautiful than those on the stems: but sometimes the inner leaves become gradually smaller, and those nearest to the flowers so very minute, that without a microscope it is not possible to dissect them away so as to expose the flower. These therefore are to be considered as the involucrems of the female flowers, surrounding and embracing the germen.

Male,

Male, or stamiferous Flower.—The antheræ are almost universally cylindrical, either straight or crooked; but in *Sphagnum palustre* and *Mnium androgynum*, they are ovate, and more or less tapering to a point. Their colour is a very dilute green, almost white. When viewed under the highest magnifiers, and strongly illuminated by reflected light, they are found to contain a granulated substance; but their tops are very pellucid, and this pellucid part expands into a rising vesicle at the time the pollen is about to be discharged. The top then opens, and the pollen is ejected, the space from which it issues becoming more transparent. This pollen, when evacuated, seems to explode in the drop of water in which the observations are to be made. Besides the antheræ included within the same involucre are some very delicate succulent bodies of various shapes.—These are exhibited in the Botanical Plate X, fig. 24; *a*, the antheræ; *b*, the succulent vessels.

In *Polytrichum* and *Mnium*, some of the barren florets are like disks, others like roses; and some like stars, when in a fully-expanded state. In the stellated *polytrichums*, the scales are placed in concentric circles; in *Mnium hornum*, *palustre*, *fontanum*, &c. they are more like a rose or a disk. After the pollen is dispersed, these roses or stars become more expanded; but previous thereto they are generally so open as to admit a view of the parts they contain. In some mosses the flowers terminate the branches, as in *Mnium pyriforme* and *purpureum*; *Bryum pellucidum*, *aciculare*, *scoparium*, *heteromallum*, *viridulum*, *simplex*, &c. in such, though a little open, they are not enough so to allow a sight of the antheræ, until the flowering be past. Some florets are like buds, and sit in the bosom of the leaves; others in the imbricated thickened termination of the branches, as in *Sphagnum*.

Female Flowers.—These are furnished with the usual female

female organs, viz. a germen, style, and stigma; but, being accompanied by other substances much resembling them, they are difficult to be distinguished until the germen begins to swell. The pistillum, after impregnation, daily growing larger, and rising upwards, puts forth the *calyptra* or veil, which may be considered as a kind of petal, and is perforated at the top by the style. This style is sometimes permanent, falling off only with the veil itself; but, where it is not so, the remains of it are always to be found. It is evident from hence, that what Linnæus called the antheræ, are really the seed-vessels: and by sowing the seeds which they contain, a crop of young plants has been repeatedly procured, in all respects similar to their parents. Joseph Fox raised plants of *Lycopodium selago*, from seed. It is singular that Mr. Miller should positively assert, in the year 1768, that mosses cannot be propagated from seed by any art; and that a journeyman weaver of Norwich should accomplish it in the year 1779!

The *capsules* of mosses are always supported upon a peduncle, though sometimes it is very short, and, excepting only in *Sphagnum palustre*, it is sheathed and conical at its base. The capsules vary in shape, size, and consistence. In some species there is an elastic ring between the capsule and the veil, which, when the seed is ripe, throws off the veil with more or less force. The veil being thrown off, certain fringe-like processes or projections appear, varying greatly in size, shape, structure, number, and disposition: they surround the opening of the capsule in a single or double, rarely in a triple, series. These substances constitute the peristoma, or fringe. The use of this fringe seems to be, to defend the seeds in wet weather. In dry weather it expands, and leaves the mouth of the capsule open; but upon the least moisture, even that of the breath, it closes again.

The

The *seeds* of mosses are spherical, generally smooth, sometimes dotted, as in *Bryum extinctorium*; sometimes prickly, as in *Bryum pyriforme* and *heteromalum*. They are brown, yellowish, or greenish.

EXAMPLE FOR INVESTIGATION.

To illustrate more fully the fructification of the mosses, we shall here delineate the parts of the *Bryum scoparium*; the antheræ and the pistillum of the *Bryum extinctorium* having been already exhibited in Plate X. fig. 24. The parts in this diminutive tribe are so extremely small, that it is impossible to observe them without the aid of a good microscope; the figures in this delineation are therefore magnified. Plate XIV. fig. 9, shows a bunch or tuft of this species of moss of its natural size, in blossom. Fig. 10, a single plant taken from the tuft, and magnified; *a*, the male floret; *b*, the female floret. Calyx: termed a perichætium, marked *cc*; the leaflets erect, sessile, lanceolate, acuminate. After impregnation of the female floret, the pistillum rises upward, upon a slender filiform footstalk, shooting out the calyptra or veil *d*, which serves as a protecting cover to the fructification. As the germen, *g*, approaches to maturity, the calyptra withers and falls away, and the germen becomes pendulous, as at fig. 11, the apex being closed by an operculum or lid, marked *e*. PERICARPIUM, fig. 12; the germen, ripened into a capsule, assumes a reddish colour, and, casting the operculum or lid, opens horizontally, and puts forth a double *peristoma*, or fringe; *f*, the outer fringe; *h*, the inner fringe; having sixteen teeth in each. When the operculum falls off, the outer fringe springs back, as shown at *f*, fig. 12; but in the space of from six to ten seconds, it folds up again, as at fig. 13, which exhibits a longitudinal section of the capsule, to show the interior *column*, extending from the base to the point of the capsule, and giving the operculum a prominent

minent or pointed appearance ; *i*, the radiated ring, fixed between the mouth of the capsule and the operculum ; this, and the fringe, forming a very curious and beautiful apparatus for the protection of the seeds. Fig. 14, the more matured capsule, in the act of discharging the seeds ; which, being extremely minute, numerous, are light, and wafted about by the gentlest breeze, till, falling into the inequalities of the bark of trees, of walls, stones, &c. they there take root, and feed at the expence of the tree, as mouldiness does on bread.

The genera of mosses, ranged under this order by Linnæus, have been lately split into several others by Hedwig and the other reformers. Hypnum and Bryum were indeed so unwieldy, that it was very desirable they should be divided. The genera of mosses as they now stand in Schreber, are, Phascum, Sphagnum, Gymnostomum, Tetraphis, Octoblepharis, Splachnum, Grimmiæ, Encalyptra, Dycranum, Trichostomum, Didymodon, Tortula, Weissia, Pohlia, Funaria, Bryum, Timmia, Meesia, Bartramia, Fontinalis, Hypnum, Leskia, Neckera, Buxbaumia, and Polytrichum.

Other mosses were placed by Linnæus in his order of Algæ ; but they are now separated from that, and form a distinct order, under the name of HEPATICA. In these, the female fructifications are inclosed in a veil, which opens at the top, and discharges the capsule. The capsule opens lengthwise, and is filled with numerous seeds, fixed to an elastic cord, formed of one or two spiral threads. Some plants are referred to this new subdivision on account of their agreement in general habit, though the female fructification has no veil, but is placed upon, or immersed in, the substance of the leaf. The leaves are mostly lobed, exhibiting a net-work of vesicles ; and, though dried, reviving again when moistened with water.

Hedwig observes, that all the female florets have a double

double calyx, or a calyx and corolla. In shape and structure, he says, they greatly resemble the proper mosses, but that he never found the succulent threads; the pistil-like substances are however found, accompanying both the germ and ripened capsule; but not in all the species. The capsule, like those of the true mosses, is inclosed in a veil, to which the style adheres; but this veil is not, as in them, loosened at its attachment, and raised along with the growing capsule; it tears open in two, three, or four, places, and has therefore been sometimes considered as a petal.— All these mosses agree in ripening their fruit, which is raised upon an elongated peduncle, and opens by four valves, filled with the seeds, attached to elastic cords. The genera comprehended under this subdivision, HEPATICÆ, are, Marchantia, liver-green; Jungermania, star-tip; Targionia; Anthocerus; Blasia; Riccia, marsh liver-wort; and Sphærocarpus.

Mosses, by the inconsiderate mind, are generally deemed an useless part of the creation. That they are not, is evident from hence; that He who made them, *made nothing in vain*. Many of their uses we know; that they have many more which we know not, is unquestionable, since there is probably no one thing in the universe of which we dare to assert that we know all its uses. Thus much we are certain of with respect to mosses, that as they flourish most in winter, and at that time cover the ground with a lively green, in places which would otherwise be naked, and when little verdure is elsewhere to be seen; so at the same time they shelter and preserve the seeds, roots, germs, and embryo plants, of many vegetables, which would otherwise perish; they furnish materials for birds to build their nests; they afford a warm winter's retreat for some quadrupeds, and for numberless insects, which are the food of birds and fishes, and these again the food or delight of men. Many of them

grow on rocks and barren places, and, rotting away, help to afford the means of vegetation to other plants, which in those situations could not otherwise prosper. Others grow in bogs and marshes, and by continual increase and decay fill up and convert them either into fertile pastures, or into peat-bogs, the source of inexhaustible fuel to the polar regions. They are applicable also to many domestic purposes: the lycopodiums are useful in dying yarn; the sphagnum and polytrichum furnish convenient beds for the Laplanders; the hypnum is used in tiling houses, stopping crevices in walls, packing up brittle wares, and the roots of plants for distant conveyance.

Mosses are observed to thrive best in barren places; and they retain moisture a long time without being disposed to putrefy. Hence the gardener avails himself of them to cover the soil and pots which contain his tenderest plants; for it equally defends the roots against the scorching sun-beams and the severity of the frost. In the spring particularly, the roots of young trees and shrubs are liable to be thrown out of the ground, especially in light sandy soils: but, if they are covered with moss, this accident never can happen. They who raise trees from seed will find an interest in attending to this remark; and, though mosses are injurious to the bark of trees, it is nevertheless a vulgar error to suppose that they impoverish land. It is true they grow upon poor land which can support nothing else; but their roots penetrate very little, in general hardly a quarter of an inch, into the earth. Take away the moss, and instead of more grass there will be less; but, if the land be drained and manured, the grass will increase, and the moss will disappear. Their pharmaceutical or medicinal virtues are but little known, and less attended to. It is probable, on account of their astringent properties, that some of them might be worth trying as a succedaneum for oak-bark in tanning leather.

ORDER

ORDER III. ALGÆ.

The true algæous plants scarcely admit of a distinction of root, stem, and leaf; much less are we enabled to describe the parts of the flowers. The genera, therefore, are distinguished by the situation of what we suppose to be the flowers or seeds, or by the resemblance of the whole plant to some other substance we are better acquainted with. The genera arranged under this order by Linnæus, are as follow: Jungermannia, star-tip; Targionia; Marchantia, liver-green; Blasia; Riccia, marsh liver-wort; Anthoceros; Lichen, liver-wort; Tremella, star-jelly; Fucus, sea-weed, vulgarly called wrack; Ulva, laver; Conferva, crow-sike, or river-weed; and Byssus. Some of these genera, approaching more nearly to the æconomy of mosses, yet differing from them in essential character, gave occasion to the latter botanists to remove them into the intermediate subdivision HEPATICÆ, above explained. So that the plants now standing in this order, are only the Lichen, Tremella, Fucus, Ulva, Conferva, and Byssus. In several of these, a discovery of the mode of propagation seems to have baffled the most indefatigable research, and still remains a subject of much doubt. According to Dr. Withering, the *fructifications* are to be found either in a kind of saucers or tubercles, as in Lichen; in globular bladders, assuming the appearance of a berry, as in Fucus, Plate X. fig. 26; or dispersed through the substance of the plant, as in Ulva. We shall state, in this place, the several conjectures relative to the mode of propagation in these plants, because it is an inquiry essential to the knowledge of Botany.

The foliage or frond of the Lichen, varies considerably in different plants. In some the substance is soft and fleshy; in others it is hard and tough, like leather: in some again it is membranaceous or fibrous;

brown; jelly-like, or horn-like; or resembling calcareous earth; and in some it even possesses irritability, or an appearance of sensation. In the Lichen ciliaris, the fringes at the extremities destined to take root, and the downy matter on the surface, have nothing to do with the parts of fructification. These are to be found in the concave saucers above-mentioned, or in convex targets or warts, either on the same or on a different plant. They both arise from a kind of knot on the under surface of the frond. The warts change to a brown, and then to a black, colour at the top; but, before they become brown, a perpendicular section through one of them discovers a single or double cell buried in the tender pulp of the plant, and filled with a granulated substance. Whenever the top of this wart or tubercle turns black, the granulated mass has then escaped through it, and only a kind of jelly remains in the cells; which, however, soon vanishes, whilst the whole tubercle becomes black and hard. This process is performed in a very short time. The rising particle, which is destined to form a concave saucer, becomes hollow and green at the top; through which if we make a perpendicular section, we find fibres radiating from its centre, and forming a semicircle, bounded by a more opaque line. As this continues growing, the saucer becomes larger, and more and more open. Its cavity is at first reddish, gradually becoming darker. At length it becomes a perfect saucer, either sitting, or supported on a short footstalk; its border is either scalloped or entire, black within when moist, and greyish when dry. If we now cut the saucer through, and examine a vertical section of it in a little water, we shall find, immediately under the black crust at top, the seeds disposed in straight perpendicular columns. When very highly magnified, these seeds appear egg-shaped, but marked with a distinct groove transversely. No unprejudiced person can therefore doubt but that the warts with the
black

black tops are the male, and the saucers the female, flowers.

The saucers, in all the species of Lichen, resemble the above in the mode of flowering, and in the same disposition of their fruit. The male flowers are also similar, whether contained like those of the Lichen ciliaris in the substance of the plant, or as in others on its surface. In some species they are found on the extremities of the branches; in others on the edges; and in others again on the under surface, where they sometimes form circles somewhat resembling saucers. The Natural Characters and Sub-divisions of the Lichens, are therefore as follow: *Male*. Scattered wart-like substances. *Female*. Smooth saucers or tubercles, in which the seeds are imbedded.—*Sub-divisions*. 1. Substance like powder. 2. Crustaceous, granulated; with black lines; with tubercles; with saucers; or with both tubercles and saucers. 3. Crustaceous, tiled, spreading, flat, fixed down to the substance on which it grows. 4. Somewhat crustaceous, leaf-like, tiled, loose. 5. Somewhat crustaceous; bearing cups shaped like a jelly-glass. 6. Somewhat crustaceous; shrub-like; shooting into branches resembling a shrub, or branches of coral. 7. Somewhat crustaceous; thread-like. 8. Leafy, herbaceous. 9. Root single; in the centre of the plant. 10. Foliage tough, like leather. 11. Gelatinous; foliage, when fresh and moist, like jelly.

EXAMPLE FOR INVESTIGATION.

The delineations we shall give of the fructifications of this very obscure order of plants, are taken from the new edition of Dr. Withering's excellent arrangement; the value of which can only be estimated by their correctness, and strict conformity with nature. Fig. 15, Plate XV. is a frond of the Lichen ciliaris, strongly magnified to show the parts; *aa*, the male warts or flowers in the substance of the plant; *b*, the female

female flower; *cc*, the fringes which expand from the ends of the branches, and strike root; *dd*, younger shoots, which have not yet given out their fibres or fringe. Fig. 16, a part of the *crenulated* lichen, to show the fructifications; *e*, the saucers, red rust-colour, varying in size, border the same, very finely scolloped; crust grey; *f*, four of the fructifications considerably magnified. These lichens are found on rocks and trees, and upon the large flints on the most elevated parts of the back of the Isle of Wight. Fig. 17, part of the *tricoloured* lichen, a very beautiful species; the saucers, *g*, orange-coloured, border pale brown; crust dull green; the saucers very minute, and deeply hollowed; *h*, four of the saucers magnified, to show the elegance of their structure; *i*, a single saucer taken from the plant and magnified.

The lichens, though generally looked upon as unworthy of notice, are of some consequence in the œconomy of nature, and afford the first foundation for vegetation. The crustaceous kinds fix upon the barest rocks, and are nourished by such slender supplies as the air and the rains afford them. When these die, they are converted into a very fine earth, in which the tiled lichens find nourishment; and, when these putrefy, and fall to dust, various mosses, as the *Bryum*, *Hypnum*, &c. occupy their place; and in length of time, when these perish in their turn, there is a sufficiency of soil, in which other plants, and even trees, take root. This process of nature is sufficiently apparent upon the smooth and barren rocks near the sea-shore. Many of the lichens also afford a grateful food to goats; and the rein-deer, which constitutes the whole œconomy of the Laplanders, and supports many thousand inhabitants, lives upon one of the species of these humble plants. Many of them afford colours for dying. One of them, brought from the Canary Islands, viz. the orchel, or argol, makes a very considerable article of

of traffic. It is not improbable, that some of the species growing in our own island may afford very beautiful and useful colours; but this matter has not been sufficiently examined. Mr. Hellot gives us the following process, for discovering whether any of these plants yield a red or purple colour: "Put about a quarter of an ounce of the plant in question into a small glass; moisten it well with equal parts of strong lime-water and spirit of sal ammoniac; or the spirit of sal ammoniac made with quick-lime will do, without lime-water. Tie a wet bladder close over the top of the vessel, and let it stand three or four days. If any colour is likely to be obtained, the small quantity of liquor in the glass will be of a deep crimson red; and the plant will retain the same colour when the liquor is all dried up. If neither the liquor nor the plant have taken any colour, it is needless to make further trials on that species."

FUCI, or SEA-WEEDS.

No subject in botany, perhaps, has been so little attended to as the investigation of marine plants; though from their variety and beauty, and the singularity of their structure, it is surprising that the attention of the ancients was never excited by them. Among the moderns, the public have now a work of singular merit to encourage, in the "*Nereis Britannica, or Botanic Description of British Marine Plants*," by John Stackhouse, Esq. And also a very elegant tract, by Major Velley, full of information, on the "*Mode of Propagation peculiar to Sea-Plants*." From these interesting pages we shall endeavour to furnish the young botanist with a pretty accurate idea of the principles of fructification in the Fucus.

"If we except the history of the fucuses written by Gmelin, who, with much ingenuity and experimental knowledge, has endeavoured to elucidate the mysterious principle by which their propagation is effected;

effected; and the general observations of Gärtner on this head, with respect to the cryptogamous class; it may be difficult to point out the work from whence any material information is to be derived, respecting the economy of nature in the origin and mode of increase peculiar to this numerous branch of the Algæ. For while we have cause to lament that the remarks which casually occur upon this particular subject in the celebrated work of Baister are so very few, and confined only to two or three species; we may find as little reason to be satisfied with the ingenious but speculative theory which Reaumur has given, in the *Acta Gallica*, upon the florescence of the fucus. It must be allowed that many descriptions, which we meet with in various botanical works, with respect to the fructification of marine plants, appear rather to be founded on the analogy supposed to exist between vegetables in general, than on any actual observations resulting from a series of experimental discoveries. To this it may be added, that much information cannot reasonably be expected from the cursory remarks of those, who pay short and casual visits to the sea-shore: when the want of seasonable opportunities to attend repeatedly to the gradual changes which these plants may undergo, must render doubtful the observations, and oftentimes frustrate the attempts, of the most ingenious investigators.

"It ought not to be matter of surprise, that so small a share of information should have been communicated to the public by Linnæus with respect to the extensive genera of fucuses and conservas. It must rather excite our astonishment, that, in the immense chaos of the vegetable world, which became harmonized and reduced to order by his arduous and unexampled assiduity, even the minutest parts should have been brought forward, and separated under such judicious and well-adapted distinctions; that the progress of investigation and arrangement, whatever
theory

theory may prevail as to the mode of propagation peculiar to each, must be unquestionably facilitated and promoted. An appeal from any part of a system, which from its distinguished excellence has justly superseded all others, must appear under an unfavourable aspect. Yet it is to be observed, that the principle itself on which Linnæus has established his system, did not by any means appear clearly ascertained to its illustrious author, as far as relates to that particular part of vegetable history which comes under our present consideration: although from the definitions of the generic characters, which he has given of the sea-plants, as well as from data laid down in sundry parts of his works, he shows how strongly inclined he was to extend his hypothesis, even to those undefined parts of vegetation, which, either from their extreme simplicity or minuteness, have vindicated the propriety of their being fixed under an anomalous arrangement with respect to the sexual system.

“We may not probably find, in the whole circle of natural history, a work more adapted to convey instruction, or which carries with it a fairer claim to pre-eminence, than the *Philosophia Botanica* of this author: nor merely as being the ground-work of the system it is meant to establish, or for the precision and beautiful mode of arrangement, which appears in every part of it; but as affording satisfactory proofs of the importance of that science, which is so evidently calculated to display the wonderful economy of Creative Wisdom. It may in some measure counterbalance the regret which must naturally arise in the inquisitive mind, from the very succinct and compendious manner in which this work is comprised, to find that many of the most important aphorisms contained in it, have given rise to several interesting philosophical disquisitions, published under the auspices and approbation of Linnæus himself, in a well-known work, entitled *Amœnitates Academicæ*. Among these, one tract

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in particular may be considered as a curious and satisfactory illustration of those data on which the sexual system more immediately depends. Here we find exemplified the protecting influence of nature, adapted to all the varied exigencies of her extensive families. Among the instances of this admirable economy, we do not meet with one more singularly impressive than that which occurs in the submersed aquatic plants. Several of these, at the critical period of their florescence, and at no other time, are observed to emerge just above the surface of the water, that the fertilizing effluvia, unobstructed in the lighter medium of the atmosphere, may without interruption attain its destined station: which end being accomplished, they soon after subside. If in plants of this description, produced in tranquil waters, such extraordinary provision for the propagation of their several species is found to be expedient; and, on the other hand, the powers of nature, according to the doctrine laid down in the system, continue to act by general and unvarying laws: it must necessarily occasion some difficulty to account for the propagation of that numerous tribe of plants, which, though permanently fixed, and frequently at considerable depths in the ocean, find an element congenial to their mode of increase. But here our inquiries are no longer supported by that analogy, which accompanies the known laws and progressive state of vegetation. Upon the first examination of a marine plant, it must appear, that the comparison, which has been made between the lacteal vessels in animals, and the fibres of roots in terrestrial plants, does not in any degree extend to the former. The roots of the fucus, so far from preparing and distributing the alimentary juices by absorbent vessels, seem by their durable and impervious texture, only calculated to secure to themselves a station. We find them attached to the smoothest stones and other bodies, utterly incapable of affording any kind of nutrition.

nutrition. From the evident properties of their roots; as well as from their general structure, these plants do not seem to possess a series of vessels, by which the fluids are propelled. It is true, this defect is in many species amply compensated for, by numerous pores variously interspersed throughout the surface of the frons. To ascertain this fact, it has been ingeniously remarked, that, if a dried specimen be immersed in water, it will soon acquire its former tone and state; but, if the experiment be only partially applied, then that part, which is kept free from moisture, will continue arid and lifeless. A conclusive argument, that the fucuses, as far as the experiment has been made, do not possess any vessels, by which the fluids may be distributed, agreeably to the more ordinary process of nature.

It may in this place not be improper to examine the theory laid down by a celebrated French naturalist, in the early part of the present century, relative to the florescence, which has been ascribed to these plants in common with all others; and made a leading principle of the sexual system. Reaumur, the author alluded to, imagined he had discovered in the *Fucus vesiculosus*, and in the *Fucus serratus*, both flowers and seeds; the former of these, indiscriminately occupying the surface of the frons. He describes each flower as a tuft of extremely minute threads or filaments, the longest of them not being a line in length; yet, after the most accurate investigation, he acknowledges he was not able to discover the antheræ at the extremities of these threads, so necessary to establish the function of the stamens; and of course was prevented from determining their precise character. In order to get over this difficulty, he confidently maintains the probability of the antheræ having fallen off at the time when the filaments first disclosed themselves: and further observes, that those flowers only, which are situated at the extremities of the leaves,

are instrumental in promoting the grains or seeds contained therein. The aperture, through which these threads appear, he considers as the calyx. In several other species, he observed the small vessels or capsules contained in the swollen and distended summits of the leaves; but not the smallest appearance of those threads or supposed floral parts. In others again, these last were very visible, without the former: for instance, the *Fucus nodosus* and *Fucus canaliculatus*, exhibited very distinctly their seed-vessels, but were entirely destitute of the filaments. Our author therefore takes it for granted, that the plants were not examined at the time of their flowering. Again, in the *Fucus palmatus*, he found the surface in a manner covered with those minute clusters of hairs or flowers, observable in the *Fucus vesiculosus*: but, after the most acute inspection, he was not able to trace out any resemblance to seeds or capsules.

"Baster and Gmelin have already shown that the theory of Reaumur is evidently exposed to the following objections. First, That, as the fine capillary filaments were always destitute of the antheræ, they could not be considered as the flowers. Secondly, That as the surface of the frons was, in some species, perfectly entire, without having the smallest appearance of those filaments, and yet abounded with the granulated vessels or seeds; while others again discovered not the least signs of any grains or capsules, and yet were overspread on every part with the fascicles of flowers: it should follow, that the parts in question are, with respect to the system, entirely independent of each other. And in addition to these remarks, it must not be omitted, that Linnæus, in his own editions of the *Genera Plantarum*, published before Baster made his objections to Reaumur, had shown his want of confidence in the assertions of that author, relating to the male flowers, by subjoining to his definition his usual *sign of doubting*. But a more striking
and

and convincing proof of this being the fact, and which it was hardly possible could have escaped the observation of Reaumur, is, that those filaments, contrary to the very nature and property of the state of florescence, are distinctly seen on the surface of the plant, in its earliest and most tender state, when it is so extremely small as hardly to have attained its natural form. They are also equally visible, when the distended summits are in a final state of decay: and during the successive periods, these small filaments do not undergo any visible change. Since, then, they are destitute of those parts which constitute the essential properties of the flower; since they are so evidently repugnant to every principle of analogy; some other use, in conformity to the structure of the plant, must be assigned to them. And from the experiment noticed above, and originally made by Reaumur, they may, with much more probability, be considered either as secretory ducts, or as vessels designed for conveying nourishment to the frons. And thus nature may compensate for the want of that supply, which land-plants, by means of their porous radicles, extract from the soil in which they are immoveably fixed; while the roots of the former seem calculated merely to counteract the fluctuating state to which they are incessantly exposed.

“Hence we may observe the wisdom of Providence furnishing to the different kinds of vegetables, properties adapted to their different situations. And while we survey the great diversity in the form, size, and situation, of seeds, in the vegetable productions of the earth; we cannot fail to remark the general uniformity, in point of situation, as well as similarity of form and size, in the organs of propagation throughout this extensive part of the algæ. In many of the fucuses, the seeds or capsules are found fixed in the leaf or frons. And in others of a more fili-form structure, as also in many of the *Conservas*, they are imbedded in the distended summits of the
pinulas

pinulas on the sides and at the extremities of the frons, or in small axillary globules formed at the base of the finer branchlets. Inasmuch then as relates to the production, situation, and habit, of these minute grains or seeds, the fucus and conferva do not seem to differ. It is not unusual to observe in the same specimen, by the assistance of a microscope, many of the opaque grains distinctly formed and conglomerated together, beneath the surface of the frons; while, in other branches, a faint cloudy appearance is the only sign which marks an approaching tendency to the same state of maturity. If any florescence preceded the fructification of these plants, it might be sought for in similar instances: yet not the smallest appearance, which could in reality justify this generally-received hypothesis, is to be found. It is worthy of notice, that Reaumur had not been able to discover these floral parts on more than five or six species throughout the very numerous genus of the fucus: and yet, circumscribed as his theory undoubtedly is, and unfounded as it appears to be, the generic character of those plants has long been established upon it. It was not probable, that Linnæus should have neglected to avail himself of a discovery so favourable to his system; and under the sanction of that respectable author. From what has been advanced, it appears that nature, in the formation and structure of this branch of the alga, has deviated from her general mode of operation: and, as there are not any proofs produced of a state of florescence attending these plants, it is highly probable, that, in this instance, she may have recourse to a simple and self-efficient mode of propagation, independent of any external accessory aid, and totally different from the principle on which the sexual system is founded. It may be proper to observe, that the opinion is sheltered under the authorities of Gmelin and Gærtner; although the latter of these authors seem to extend

his

his hypothesis in too general and exclusive a manner. Gmelin observes, that it would not be less absurd to require, than difficult to attempt, an explanation of the natural process which takes place in the original formation of the granulated vessels discovered in the fucuses. We must ever be at a loss, when we approach towards the first principles of any efficient cause. The same inexplicable difficulties occur in the regenerating springs of animal life. All that can rationally be asserted, is, that from these and similar observations, it appears, that it hath pleased the great Author of Nature to produce the same effects by a more simple process in some instances than in others: and that, in the various species now under consideration, it should seem to be ordained, that a self-efficient power, essentially existing in these plants, answers every purpose conducive to their propagation.

“ For a more particular elucidation of this subject, it may be proper to consult the work of Gmelin, who further observes, that in the plants now under consideration, a gradual process may be traced from those, which are unisexual, to others still more simple, and which are perfectly asexual. To the first of these distinctions Gærtner attributes the fructification of the more perfect fucuses, which he maintains are propagated by actual seeds. Under the latter division, the same author has decidedly fixed many of the fucuses, and all the conservas without exception.

“ It may be necessary briefly to notice the definitions, which Gærtner has given of vegetable propagation, in order more clearly to understand that part of his theory which is applied to the extensive genus of conservas. He considers the source of vegetation as dependent on a two-fold principle. One of these, by virtue of an inherent vital force, operates without any impregnation, in producing a distinct and perfect epitome of the mature plant, simply from the medullary substance. The other, by an operation
of

of the organized parts, digests and separates proper secretions from the general mass, till at length, by a more complex process, an entire new organized body is produced, and the exact rudiments of plants are formed in distinct and appropriate parts. This is termed *fructification*, as producing seeds: the former, is considered as a simple proliferous mode of increase. The author then applies these principles to the different parts of the cryptogamous class. All the conservas, whether capillary or beaded (*moniliformes*), he maintains, are entirely destitute of seeds, and have not even the shadow of affinity to the sexual system. The moniliform or beaded conservas, e. g. *Conserva corallinoides*, and others, throw out from their greater joints, small lateral filaments of the same form and structure; which constitute the only source of propagation, by a process very simple in itself; as one or sometimes two of these joints are, by the mere intumescence of their internal substance, converted into a single globule; which, after it hath separated from the original stock, immediately adheres to the rock or body on which it happens to light, and from the upper part extends itself into a new joint; till at length it grows up into the exact form and similitude of the proliferous parent plant. These globules, Gærtner observes, have a very strong resemblance to the fructified parts of plants, in their texture as well as in their form and colour; yet, upon examination, he affirms, they will be found to be simple germens, consisting of mere medullary substance, contained in a homogeneous bark or covering: from which circumstance, as well as from the confluence of those joints into a globule, he maintains, that they do not depend upon any other principle than the simple faculty of vegetation for their mode of increase. But, although Gærtner asserts that the conservas, as well as all those fucuses which are membranaceous, are subject only to a proliferous mode

mode of increase; yet we have the clearest proofs, that many of the latter derived their propagation from seeds, in every respect as unequivocally as those fucuses which have been deemed more perfect. The *Fucus rubens*, i. e. the *crenatus* of Gmelin, is truly membranaceous, very thin in its texture, and nearly transparent. The central nerve, which pervades the frond, frequently branches off in opposite directions, producing numerous leaves, which at first sight may appear as the deciduous offsprings of the prolific parent stock. The margins of these leaves are oftentimes closely fringed with minute spines; each of which in time becomes a kind of capsule, containing many seeds of a faint purple colour. Not one of these seeds, when magnified, appears much larger than a particle of sand. The *Fucus crispatus* of Hudson, although as delicate in its texture as the finest *ulva*, contains within its segments minute innate vesicles, which abound with a remarkable quantity of grains or seeds, in every respect very similar to those which are observed in the perfect plants of this genus. Several other membranaceous fucuses, which have been (in the *Syst. Nat.*) lately separated from the rest, as being supposed subject only to a prolific increase, leave us no reason to imagine that they are destitute of seeds. Even Gmelin, who (in *Hist. Fucor.*) seems first to have established that division, describes a plant of this order, the margins of which were surrounded with opaque globules; and without being prejudiced in favour of his former opinion, candidly endeavours to account for the cause of this appearance, by attributing it in some degree to a state of maturation: which, according to the more ordinary course of nature, had produced those repositories for seeds, on which the propagation of the species might probably depend.

“ A proper generic distinction between the *fucus* and *conferva* does not yet appear to be established, as

the characters of both genera are sometimes blended together. The transverse diaphragms and joints, the tenuity and capillary structure, are the common obvious marks of distinction in the *Conervas*. Yet we find some species of the latter described as not being jointed; while some of the *fucuses* are furnished with diaphragms. The genus *Ulva* still adds to the confusion, by sometimes partaking of the properties peculiar to each of the former. The *Ulva capillaris* of Hudson, for instance, has been frequently found with spherical vesicles in great abundance at the extreme branches; in which may be discovered several pear-shaped grains or seeds, hardly differing in colour from the rest of the plant: from this circumstance it might rank with the *Fucus*. The *Ulva articulata*, in its jointed appearance, approaches very nearly to the character of the *Conserva*: while the *Fucus filum* exhibits a series of diaphragms, which might justify its being added to the last-mentioned genus. The *Fucus incurvus* seems to unite the distinctions of both genera; for the pinnulas, in the recent plant, when held to the light, frequently discover a regular course of septas, which are not to be observed in the other parts of the *fucus*. The inflated leaves of the *Fucus filiquosus*, which, from their strong resemblance to pods, have furnished this plant with its trivial name, are subdivided by diaphragms that are even palpable.

“ It has frequently been remarked, that Nature proceeds, as by a regularly-extended chain, from plants of the most simple and unorganized state, to others, which, from being more complex in their structure, are therefore deemed more perfect. This favourite idea of a connecting series, seems to have been followed by a more apposite comparison of an ingenious author, who, observing in how close and inseparable a manner the orders of Nature are sometimes blended together, illustrates the process by a metaphor,

metaphor, drawn from the interwoven meshes of a net, which are united together by a multifarious connection. Without contending for the justness of the application to the plants in question, and which are reckoned among the primary and most simple of the natural orders; certain it is, that the *Conferva*, *Ulva*, and *Fucus*, are not at present separated by fixed and permanent generic distinctions, and that they sometimes participate in properties peculiar to each. The *Ulva articulata*, for instance, notwithstanding its striking resemblance to the *Conferva*, is considered by Lightfoot as a *Fucus*; the *Conferva fistulosa* of Dillenius (i. e. *Conferva tubulosa*, of Hudson) is placed under the genus *Ulva* by Linnæus.

“Gærtner readily admits that the more perfect *Fucuses* are produced from seeds, and as confidently maintains, that the extensive genus of *Conservas* derive their propagation from a totally different source; and that, in several species of the latter, it is effected solely by the small lateral filaments, which from intumescence assume the form of globules, and, falling off spontaneously from the branches, become in their turn the sources of a proliferous increase. There are, however, beyond a doubt, many *conservas*, which at particular seasons produce opaque granulated vessels or seeds, contained within those very globules, probably, which this author mentions as being in themselves the original and only source of increase. He has unfortunately fixed upon the *Conferva corallinoides*; a species, of all others, least favourable to his hypothesis. This *conferva* is of so simple a texture, that it has the appearance of a fine tubular transparent membrane, which at length acquires a beautiful crimson fluid. In this state, it is sometimes, but not frequently, discovered, with dark clusters or protuberances surrounding the joints. These, when under the microscope, are found to contain a great number of dark purple ovate vessels;

but whether the latter are seeds, or only pericarpiums containing more minute particles, does not appear. If the plant at this time be placed between papers, it will soon discharge its interior crimson fluid, leaving only a jointed transparent film, the vessels at the joints excepted, which retain a degree of solidity and opacity very different from the other part of the plant. Now, as these granulated bodies are so very distinct from the internal substance of the *Conserva*, it is highly probable they are formed by that process and peculiar separation of the general mass on which Gærtner scientifically establishes the origin of seeds, in contradiction to the simple increase of medullary substance on which he has founded the principle of propagation by germens. In short, that, by a secretion of the fluid, an entire new organized body is formed; or, in other words, the pericarpiums or seeds. If then, according to this author's mode of reasoning, the grains contained in the more perfect *Fucuses* are actual seeds, and the sources of increase, it should follow, from the instances just given, and from others which might be produced, that the *Conservas* also derive their propagation from the same principle.

“ This opinion should seem more probable than that laid down by Gærtner, because the origin of all these plants is imperceptibly small; since we find them growing upon the smoothest and most glossy surfaces of plants, and as frequently upon the finest capillary branches of *Fucuses*; full as minute as the *Conservas* that are attached to them. In these fine branches, however, there must be some nidus, or repository, sufficiently capable of affording shelter and protection to those minute seminal atoms, which escape from vessels similar to those before described. Neither is it easy to conceive in what manner the mode of propagation could succeed, according to Gærtner's theory; for, as the *Conservas* are frequently

quently of an equal size with those branches which support them, it is by no means probable, that the jointed globule of a *Conferva* (if this be the author's meaning) could so instantaneously attach itself to such a body, and with tenacity sufficient to resist the constant collision of tides. That the globules consist of the medullary substance of the plant itself is readily admitted; at the same time it must be allowed, that all the *Confervas*, which produce the granulated vessels or seeds imbedded in those globules, bear a striking resemblance, in their mode of propagation, to the more perfect *Fucuses*; and, not being apparently subject to the laws of floescence, attain their state of fructification in a manner exactly similar to that which has been ascribed to the latter; from an inherent self-efficient principle, equivalent indeed, though entirely different, to that on which the sexual distinction is founded."

The generic character and subdivisions of the *Fucus*, assumed by Professor Martyn and Dr. Withering, are as follow: *Fructification*, consisting of capsule-like globules, or of granulations within the substance of the plant, with a perforation above them. *Male*: Vesicles smooth, hollow, with villose hairs within, interwoven. *Female*: Vesicles smooth, filled with jelly, sprinkled with immersed grains prominent at the tip. Seeds, solitary. The *essential character* cannot, in the present state of things, be fully ascertained. The subdivisions by Dr. Withering are as follow: 1. *Fucus* with bladders in the substance of the leaf. 2. With the leaves pod-like. 3. With the branches of the frond jointed, like a necklace. 4. With the frond flat, midribbed; *opaque*, or else *pellucid*. 5. The frond flat, but ribbed; *opaque*, or else *pellucid*. 6. Branches of the frond cylindrical; and either *opaque*, or *pellucid*. 7. Frond capillary, divided also into *opaque*, and *pellucid*.

EXAMPLES for INVESTIGATION.

The subjects we shall now delineate, are taken from Major Velley's recent publication; the first of which is the *Fucus vesiculosus*, or sea-oak; being one of those containing bladders. This fucus commences its vegetation by a frond or single leaf, and grows upon the surfaces of rocks and shells. Its base appears like a thin glutinous substance, strongly adhesive to the body on which it is fixed. In the further stages of its growth, the foliaceous part is frequently worn away by the force of the surge, and the middle rib or nerve acquires all the appearance of a solid stem, being entirely bare and nearly cylindrical, for the space of half a foot or more above the base. The frond in the mean time continues increasing, in a dichotomous mode of growth, to a considerable extent, furnished with numerous branches. It has also air-bladders for the purpose of buoyancy; and at length terminates with distended summits, containing a tough gelatinous mass, around which a number of callous globular tubercles are fixed to the interior side, (as represented in Plate XV. fig. 18;) each of which is furnished with many seeds. When the plant arrives at maturity, the mass becomes mucilaginous, and by the help of glasses appears to be enveloped with fine capillary vessels irregularly reticulated. At this period, several small punctures or perforations are frequently visible on the surface of the summit, and the tubercles now have a more prominent appearance. This latter circumstance is in some measure owing to the dissolved state of the gelatinous substance. Each puncture is subtended by the upper part of its respective tubercle, and is no doubt the channel through which the sources of propagation are dispersed.

A specimen of this fucus in its last stage of maturity, and approaching to decay, being examined, the capillary

lary vessels in the summit were found to be asperfed with a substance not unlike the farina of a plant. In order to discover the cause of this appearance, a single tubercle, detached from the summit, was placed under the microscope, and cautiously pressed with a fine instrument; when one of the minute grains contained within it was seen to explode, and with an elastic force seemed to discharge a pulverized substance, somewhat similar to the particles which proceed from a *Lycoperdon*, or truffle. The extreme minuteness of the object defeated all attempts to prosecute the experiment. And we are not authorized upon an accidental appearance to assert that the particles in question were analogous to seeds; since they might possibly be ascribed to the decay and putrescent state of those granulated bodies. And yet, in favour of the former opinion, it may not appear improper to observe, that the powder proceeding from the *Lycoperdon bovista*, and which exceeds all calculation, is, according to the late ingenious Mr. Lightfoot, considered as the seeds of that plant. If then these minute grains, which in some species of marine plants are but few in number, should prove at last not to be the actual seeds, but only pericarpiums containing the seminal atoms; we may be enabled more readily to account for the promiscuous growth of those plants on the finest edges of each other, as well as on the smoothest surfaces of hard extraneous bodies. The central nerve seems indued with an active vital principle, from whence, upon any fracture, new leaves shoot forth. There are several varieties of this species. One of them is represented in the plate, to which the *Conserva fucicola* is attached. They have been considered by some as distinct species, but Gmelin very properly brings them back to one specific character.

Fig. 18, part of the frond of the *Fucus vesiculosus*, bladder-fucus, or sea-oak, with distended summits,

mits, in its natural size. Fig. 19, the apex magnified, to show the perforation through which the seeds are dispersed. Fig. 20, a tubercle in its natural size, and scarcely larger than a grain of mustard; with a figure of the same as it appears when highly magnified. Fig. 21, part of the tubercle, containing the seeds or grains. Fig. 22, a small part of the frond magnified, to show the fine capillary vessels or hairs, which Reaumur considered as the male flowers; and on which the above *male character* was assumed. Fig. 23, a small part of the frond of another plant, to show the *Conferva fucicola*, marked *a*, attached to it. Fig. 26, Plate X. illustrates the *Fucus coccineus*, or scarlet fucus, a species of the capillary pellucid kind; with fructifications black and globular.

The *Conservas*, or river-weed, are all inhabitants of the water, some in fresh, but most in salt, water. Their specific character is as follows: Filaments most simple, capillary, jointed very short, crowded together, containing globular granules. Fig. 24, Plate XV. represents a very minute *conferva*, the same as on the fucus, fig. 23; but it does not seem to possess that indifference with respect to the place of its growth which marine plants generally do. The filaments are tubulous, and have numerous diaphragms; their termination is obtuse. When viewed separately they are almost transparent, or have a light yellow tint; but in the mass their colour is deeper, and partakes of a muddy yellow or brown. It is found in great abundance under an elevated cliff near Weymouth, called the Look-out; particularly in the spring months. The fructification of this species has not yet been discovered. A very singular instance of irritability has been observed by Major Velley in the *Conferva corallina*, upon its being immersed, in a recent state, in fresh water. After it has been in the water a few minutes, several fibres were observed to move in an horizontal direction with a quick convulsive

vulsive twitch, and then to stop suddenly: this they continued to do for some length of time; and the effect may be produced several times, provided the plant be fresh. It is remarkable that this experiment does not succeed in salt water.

All the sea-weeds are valuable as manure, and are used to great advantage by the farmers on the coast. Others burn them to make kelp, by which they constitute a valuable article of commerce. Many species make beautiful specimens for the herbarium; and are often seen disposed on paper so as to form a sort of picture. The more tender plants are used as food; such as the *Fucus saccharinus*, *digitatus*, *palmaris*, &c. which are eaten boiled, with butter, pepper, and vinegar. If the first of these be washed in spring water, and hung up in a warm place, a substance like sugar exudes from it. The last-mentioned species is called by the Irish *dullish*; by the Scotch *dills*; and in Northumberland *dulls* or *dulse*. Being soaked in fresh water, it is afterwards hung up, and eaten dried, in which state it has something of a violet flavour. It is sold in the streets of Dublin after being dried, and is said to sweeten the breath and kill worms. They also constitute the food of various kinds of fish.

ORDER IV. FUNGI, or MUSHROOM.

This order consists of plants mostly of a cork-like texture, and of short duration, bearing their seeds either in gills or tubes, or attached to fibres, or to a spongy substance. Hedwig and other modern botanists have made some important discoveries respecting the fructification of funguses, by the help of high magnifiers. The seeds are a dark powder in the gills of the agarics; in the boleti the seeds are within the membrane that lines the tubes; in *peziza cyathoides* they appear to be inclosed in a sort of pod, &c.

The Fungi are extremely numerous, and are divided into the following genera, viz.

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1. AGARICUS:

1. AGARICUS: fungus with gills underneath.
2. MERULIUS: with veins underneath.
3. BOLETUS: with pores underneath.
4. THELAPHORA: warty underneath.
5. HYDNUM: prickly underneath.
6. PHALLUS: smooth underneath, cellular above.
7. HELVELLA: turbinate, plaited, wrinkled.
8. ATRACTOBOLUS: sessile, cupular, with a lid, ejecting fusiform vesicles bearing the seeds.
9. TYMPANIS: cup-shaped; the cupola with a curtain above; seeds dry, mouldering to powder.
10. MYROTHECIUM: cup-shaped; the cupola with a curtain above; seeds rather viscid.
11. XYLOSTROMA: expanded, coriaceous, smooth, equal; seeds globular, very minute, seated within the fibres of the fungus.
12. HELOTIUM: with a fleshy-membranaceous convex-hemispherical cup, bearing the naked seeds underneath.
13. CLAVARIA: elongated, erect, clavate, emitting the seeds from every part of its surface.
14. CLATHRUS: roundish, concealed with fleshy branches interwoven with each other.
15. PEZIZA: concave; seeds contained in the cup.
16. VOLUTELLA: salver-shaped, on a short setaceous stalk; upper-surface of the cap dotted and umbilicate; the margin at first revolute; seeds similar.
17. EPICHYSUM: rounded and concave; seeds globular, tailless, affixed by a branched thread creeping within.
18. CYATHUS: campanulate or cylindrical, bearing lentiform, capsules within.
19. ASCOBOLUS: hemispherical; vesicles oblong, scatteringly and slightly immersed on the disk, elastically ejecting the seeds.
20. THELEBOLUS: sessile, gelatinous, solid, ejecting a gelatinous substance bearing the seeds.

21. SPHÆ-

21. *SPHÆROBOLUS*: sessile, globular-concave, opening in a radiate manner, and ejecting a globular capsule.

22. *PILOBOLUS*: on a capillary stalk inflated and watery at top; cap hemispherical, elastically ejecting the seeds.

23. *PUCCINIA*: cylindrical, filled with tailed seeds, disposed in a radiate manner, and escaping elastically.

24. *LYCOPERDON*: becoming powdery and fibrous within; seeds attached internally to the fibres.

25. *SPUMARIA*: follicles branched, filled internally with seminiferous fibres, covered with a cellular branny bark.

26. *FULIGO*: with a cellular-fibrous bark; the fibres penetrating in a reticulate manner through a seminal mass.

27. *STEMONITIS*: covered with a fugacious or membranaceous bark, filled with seminiferous fibres elastically expanding themselves.

28. *MICROCARPON*: with a membranaceous case opening irregularly, filled with seminiferous filaments reticulately compact and fixed to the base.

29. *CRIBRARIA*: with the case furnished with a double membrane; the outer thin and fugacious; the inner reticulate; seeds without filaments, ejected through the foramina.

30. *RETICULARIA*: roundish, furnished with a case filled with seeds dispersed among reticulate filaments.

31. *TUBIFERA*: furnished with cases superimposed on an expanded membrane, connected with each other, and filled with nearly naked seeds.

32. *ÆCIDIUM*: furnished with membranaceous cases, glabrous both sides, filled with naked seeds not cohering.

33. *SPHÆRIA*: furnished with cases, filled with roundish naked gelatinous seeds.

34. **HISTERIUM**: sessile, hollow, with a transverse cleft at top; seeds globular, tailless, covering the disk.

35. **VERMICULARIA**: capsule globular, sessile, filled with loose worm-shaped seminiferous bodies.

36. **PYRENIUM**: globular, sessile, very entire, inclosing naked conglobate seeds like a nucleus.

37. **TUBER**: nearly globular, fleshy; the flesh distinguished internally with veins.

38. **SCLEROTIUM**: quite simple, globular-oblong, tough, hardish, gaping a little at length in the centre, covered with an inseparable bark never opening above.

39. **UREDIO**: powder mealy, destitute of a case, effused under the cuticles of leaves and stems, bursting at last with an even margin.

40. **TUBERCULARIA**: gelatinous; cap tubercled; stalk thick, filled, closely appressed, bearing the seeds on the upper surface.

41. **SPERMODERMIA**: quite simple, globular, sessile, spongy; seeds crowded, supplying the place of a bark.

42. **ACROSPERMUM**: quite simple, nearly erect, emitting the seeds exteriorly from the tip.

43. **STILBUM**: aggregate, gelatinous, on a stalk; head diaphanous, shining, solid, permanent, bearing the seeds externally.

44. **ASCOPHORA**: erect, on a setaceous stalk; head globular-oblong, inflated, opaque, elastic, bearing the seeds eternally.

45. **CHORDOSTYLUM**: very tenacious, on a very long tenacious slightly branched stalk; head globular, somewhat deciduous, bearing the seeds.

46. **MUCOR**: fugacious; heads at first diaphanous, becoming opaque, fixed to simple or branched stalks.

47. **HYDROPHORA**: globular, watery, on a nearly erect capillary stalk.

48. **PERI-**

48. *PERICONIA*: globular; seeds sessile, deciduous, every where clothing the head and stalk.

49. *GRANULARIA*: roundish, filled with granulations immersed in a mucilage.

50. *MEDUSULA*: solid, globular, on a stalk, crowded; seeds external, filiform, flexile, colliquescent.

51. *MONILIA*: consisting of moniliform filaments clustered into a head.

52. *MUCILAGO*: consisting of most simple fugacious filaments.

A new classification of Fungi has been recently published at Leipzig, (1805,) according to the method of Persoonia, by I. B. de Albertini and L. D. de Schweinitz. The species and varieties they have added are 127 in number, on twelve beautifully-coloured plates. The whole is divided into two classes and six orders. Their new genera appear to be the following:

53. *Stilbospora*. 54. *Hyloma*. 55. *Næmaspora*.
 56. *Geastrum*. 57. *Bovista*. 58. *Tulostoma*. 59.
Scleroderma. 60. *Pisolithus*. 61. *Lycogala*. 62.
Phyfarum. 63. *Trichia*. 64. *Arcyria*. 65. *Lycea*,
 66. *Tubulina*. 67. *Onygena*. 68. *Trichoderma*.
 69. *Conoplea*. 70. *Amanita*. 71. *Sistotrema*. 72. *Merisma*.
 73. *Geoglossum*. 74. *Spathularia*. 75. *Leotia*.
 76. *Morchella*. 77. *Tremella*. 78. *Agerita*. 79. *Ceratium*.
 80. *Isaria*. 81. *Botrytis*. 82. *Dematium*.
 83. *Erineum*. 84. *Racodium*. 85. *Hemantia*. 86.
Rhizomorpha. 87. *Mesenterica*.

The following are the principal discoveries of Hedwig on the subject of Fungi. On dividing the *Agaricus amanita* longitudinally, before the curtain had begun to separate from the edge of the pileus or cap, the whole inner surface at first appeared white; but, while the operator was examining some still whiter lines in the flesh of the pileus and stem, the upper and under surface of the curtain changed to a violet, and in a short time after to a brownish colour. On raising

raising a small portion of this surface, and viewing it under high magnifiers, Hedwig discovered pellucid succulent vessels, and innumerable oval globules connected therewith, of a dilute brown colour. The part from which this portion had been taken away, did not change colour again. He next examined a portion taken from one of the gills, whilst it was yet white. It was divisible, though not readily, into two lamina. The lower edge was thickly set with tender cylindrical substances, some of which had a globule at their extremities, but others not. The gill itself appeared of a reticulated structure, with larger and more distinct spots, a little raised. In another older plant of the same species, wherein the curtain was torn, the pileus pretty fully expanded, and the gills turned yellow, the upper part of the stem began to be tinged by a brown powder shed from the gills. It was evident, on examination, that this brown powder was the seeds, and that it proceeded from the larger spots before observed in the gill, the two laminae of which now readily separated. There is therefore great reason to believe that the stamina are the globules attached to the threads found within the curtain; when these vanish, the plant continues to grow until it scatters its seeds, and then it dies. Hence it should seem, that the full expansion of the pileus indicates the maturity of the seeds, and that the fructification is performed previous to the rupture of the curtain.

On examining the curtains and the rings of different Agarics and Boleii, the above-mentioned globules were always found on their upper or inner surfaces. In some of the yellow Agarics, they are so numerous on the upper surface, as to stain the fingers when touched, but the under side is smooth and entirely destitute of them. Some few Agarics seem to have only a row of these threads beset with globules at the edge of the pileus, whilst it is in contact with the

the stem; and upon this expansion they shrivel and drop off. It is true that in many Agarics we neither find curtain nor ring, nor these threads at the edge of the pileus; but, when this is the case, the threads are placed upon the stem; and may readily be found by examining the plant in its very young state, before the edge of the pileus separates from the stem. This structure takes place in many of the Agarics, the *Hydnum imbricatum*, and the *Boleti*, which are rarely furnished with a curtain. After the pileus in these is expanded, and the stem grown longer, its upper part, where the stamens were seated, becomes reticulated. The seeds of the *Boleti* are found within the membrane that lines the tubes.

The stemless Agarics and *Boleti* present similar appearances about the edge and at the base. Something of the same kind is also found in the *Peziza cyathoides*, whose seeds appear to be inclosed in a kind of pod; and likewise in one or more of the *Lycoperdons*; but these have not yet been sufficiently examined. Whether the succulent vessels in the margin, or the surface of the gills, or the mouths of the tubes, be, or be not, styles and stigmas; or whether they are designed for any other purpose, could not be ascertained. It is therefore evident, that for the practical purposes of investigation, the minutiae of the fructification can at present avail us but little.

The dark powder in the *Lycoperdon* and *Mucor* was seriously taken for *animalcules* by Baron Munchausen; and thus the whole tribe of Fungi were on the verge of being ranged in the class of Zoophytes. According to the baron, those globules, which appear almost black, are semi-transparent, and contain a black particle. If they be mixed with water and kept in a warm place, they presently swell, and are changed into ovate animalcules, that in a few days unite and form a mass of pretty firm texture, which is the fungus. Mr. Ellis however has satisfactorily shown,

shown, that the motion of these globules was occasioned by a number of very minute animalcules feeding upon them; and these, being much smaller than the globules, are difficult to detect, on which account, it seems, the baron overlooked them. It is now, therefore, universally admitted, that all the funguses are real vegetables, producing seeds by which they have been propagated, and generally maintaining a monoecious character.

EXAMPLE FOR INVESTIGATION.

The species here delineated, is the *Agaricus campestris*, or common mushroom. The plant consists of a cap or cover, called the *pileus*, with gills underneath; and a *volva*, or curtain, which in the young plant shuts up the tender gills, and unites the pileus with the stem. Fig. 25, Plate XV. is a longitudinal section of the mushroom, to show the interior structure: *a*, the pileus or cap; *b*, the gills; *c*, the stem; *d*, the ruptured curtain, here forming a ring. Fig. 26, represents the plant entire, where *d*, the curtain, is just beginning to separate from the pileus, whereby the gills become exposed, and the seeds disseminated. Fig. 27, a portion of the gill, to show the fructification, or unripe seeds. Fig. 28, the ripe seeds. Fig. 29, the radicles or roots arising from the disseminated seeds, vulgarly called the mushroom spawn; also, the young plants just emerging from the bed.

Many of the fungus tribe are much esteemed in foreign countries as a luxurious food, on account of their high flavour. We in England almost confine ourselves to the *Agaricus campestris*, the morell, and the truffle: but in Russia we are told that they are eaten almost indiscriminately, salted and thus kept for winter use. That many have suffered disease, and some even death, from eating voraciously or incautiously of the funguses, is certain; it is doubtful however whether many of them be really poisonous,
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In the strict and proper sense of the word. A great variety of insects feed on the different species, particularly the larva or maggots of many of the *musca*, or fly genus. Some funguses have been found of considerable use in stopping external hæmorrhages; and the acrimonious qualities of others will probably at some future period be turned to good account.

PALMÆ, or PALMS.

The order of Palmæ comprehends such plants as have a *spadix* and *spatha*; and consists of nine genera, viz. *Chamærops*, dwarf-palm, or palmetto; *Borassus*, palmyra-tree, or fan-palm; *Corypha*, mountain-palm; *Cocos*, cocoa-nut tree; and *Elæis*. These five genera are, by the new arrangement, removed into the class Hexandria. *Phoenix*, common palm, or date-tree; and *Elate*, wild Malabar palm; both removed into the class Triandria. *Areca*, cabbage-tree; now in the class Enneandria; and *Caryota*, removed to the class Polyandria. To these, several new genera have been lately added.

Thus have we conducted the young botanist through all the Classes and Orders of the Sexual System of Linnæus; and carefully noted the alterations and changes it has undergone since his time; particularly the abolition of his 20th, 21st, 22d, and 23d, classes, which, as we have seen, are now carried into other parts of the system. This new arrangement, however, though pretty much the vogue, is not followed by Professor Martyn in his new and valuable edition of Miller's Botanical Dictionary; nor by Dr. Roxburgh, in the magnificent work he is now publishing, under the auspices of the East-India Company. Another botanical production, of considerable reputation for the elegance of its execution, has been recently published by Dr. Thornton, who proposes to reduce the classes of Linnæus into *twelve*, and wholly

to new-model his genera. Without meaning to cast any imputation upon the plan, we only hope it may not prove an additional stumbling-block in the way of a learner, already too much embarrassed by the rage for multiplying systems, the whole of which he must have to learn, before he can be said to understand the science. The inconvenience of fanciful and arbitrary arrangements we shall now endeavour to demonstrate, by bringing into the reader's view a succinct narration of the ancient methods of classing vegetables, and of the numerous imperfect systems that were in use, before the sexual hypothesis was adopted; all of which the botanical student must of necessity be acquainted with, before he can properly understand the different botanical writers, or appreciate the merits and improvements of Linnæus.

Of the VARIOUS BOTANICAL SYSTEMS.

AT the commencement of this volume, we briefly enumerated the most celebrated botanical writers in the ancient school. It will there be seen, that Theophrastus among the Greeks, and Dioscorides among the Romans, were the most eminent for their scientific distinctions. Theophrastus first allotted seven obvious distinguishing characters to vegetables, viz. the generation of plants; their place of growth; their size, as trees and shrubs; their use, as pot-herbs and esculent grains; and their lactescence, or liquor that flows from them when cut. Dioscorides afterwards divided these into aromatic, alimentary, medicinal, and vinous, plants. The good properties of this method are, that the botanist comes to the point at once; and, when he knows the plant, knows its virtues and uses, or at least part of them: but this convenience is greatly overbalanced by innumerable disadvantages; for the qualities and virtues of plants are not fixed and invariable; neither are they impressed in legible characters on the plants themselves. The different

different parts of a plant often possess different and even opposite qualities; so that supposing the virtues to be known, and applied to the purpose of vegetable arrangement, the root must frequently fall under one division, the leaves under a second, and the flower and fruit under a third. Besides, if we reflect that the sole end of such arrangement is to facilitate the knowledge of plants to others, the insufficiency and even absurdity of methods founded upon their virtues will immediately appear. A stalk of vervain, for instance, is presented to us, which we are to investigate from a pre-supposed knowledge of the virtues of plants. Before we can settle the class to which it belongs, we must discover whether or not it has the virtues belonging to any of the plants we previously know; and this discovery, being the result of repeated experiments on various parts of the human body, may require many years for its accomplishment.

The same causes which render methods founded on the virtues of plants unfavourable for the purpose of investigation, must evidently disqualify all their other variable quantities and qualities from having a place in a genuine systematic arrangement. The *natale solum* of plants, which is one of Theophrastus's divisions, affords no better distinctive characters than their powers and virtues. Many countries as well as many soils produce the same individual plants. The same species which crown the mountain, frequently cover the fens; and plants which have long been considered as the peculiar inhabitants of some parts of Asia and America, are now found to grow naturally in equal perfection in the very different climates of Lapland and Siberia. The *size* of plants, which suggested the ancient division into trees and shrubs, is no less an equivocal mark of distinction than the circumstances already mentioned. The vine, which modern botanists denominate a shrub, was ranged by Theophrastus

tus in the class containing trees. In fact, every thing respecting *size* is so much affected by difference of soil, climate, and culture; that the same plant, in different circumstances, shall differ exceedingly in height; and in a method founded upon the size, would sometimes be ranged as a tree, and sometimes as a shrub, or even an under-shrub, according as it happens to exceed, equal, or fall short of, a given standard. No less insufficient are characteristic marks drawn from the colour, taste, and smell, of plants. Of all the attributes of vegetable nature, colour, as we have already seen, is perhaps the most inconstant. Heat, climate, culture, soil, &c. contribute to the production of endless diversities of colour, and render the transition from one to another natural and easy. Red and blue pass easily into white, white into purple, yellow into white, red into blue, blue into yellow, &c. These considerations are abundantly sufficient to show the imperfections of the earlier systems of botany; and, indeed, considering the vague and uncertain marks by which the ancients distinguished one plant from another, we may rather wonder how such a science came to have an existence among them, than that they arrived at no greater perfection in it, or suffered it so soon to fall into obliuion.

The virtues and colour of plants being thus found an insufficient characteristic, succeeding botanists had taken in the root, stem, and leaves; but, these being also found insufficient and variable, Gesner turned his eye to the flower and fruit, as being the most permanent and unchangeable parts of the plant. In proposing the parts of fructification, however, as the most proper for arranging plants, he communicated no hints respecting the choice of some of those parts in preference to others. Each particular organ of the flower and fruit furnishes sufficient variety to serve as the foundation of the method; but all of them are not equally proper for this purpose. Cesalpinus, the
first

first follower of Gesner, made a mistake in his choice, and took his distinguishing characteristics only from the fruit. The parts of the flower, therefore, being employed by the first systematic writers only as subaltern directions in finding out orders and genera, it is evident that the plant could not be fully investigated for several months. Suppose a plant ripens its fruit in October, and does not produce flowers till the following May: the class, upon inspection of the fruit in the month of October, is immediately ascertained; but the plant still remains unknown, and will continue so upwards of six months after, if the characters of the order and genus have been made to depend on any part of the flower. Methods founded on the fruit have another inconvenience; plants constantly ripen their fruit in those countries where they grow naturally, but not always in the countries to which they may be accidentally transported. So far from this, many plants that are natives of a warm climate neither ripen nor form fruit in a cold one. Few of the African, Asiatic, and West-Indian, plants, produce fruit in Great Britain. A method, therefore, founded upon the fruit, could only facilitate the knowledge of such plants to the inhabitants of those countries where they grow: to the English botanist they could be of little or no service. The same objection cannot reasonably be urged against methods founded on the flower, since the influence of climates much colder than that of our's has not been able to destroy the faculty of producing flowers in most, if not in all, the plants just mentioned.

Cæsalpinus sets out with an ancient distinction of vegetables, from their duration, into trees and herbs. With the former he combines shrubs; with the latter, under-shrubs; and he distributes his plants into the fifteen following classes: 1. Trees with the germen (radicle or principle of life in the seed) on the point of the seed. 2. Trees with the germen on the base of

of the seed. 3. Herbs having one seed only. 4. Herbs having two seeds. 5. Herbs having four seeds. 6. Herbs having many seeds. 7. Herbs having one grain or kernel. 8. Herbs having one capsule. 9. Herbs having two capsules. 10. Herbs having fibrous roots. 11. Herbs having bulbous roots. 12. Herbs having succory or endive-like flowers. 13. Herbs having common flowers. 14. Herbs having several follicles or seed-bags. 15. Herbs having neither flower nor seed.

The inconveniences of this method have been in part pointed out already, and will more evidently appear upon an attempt to refer any common plant to one of the fifteen above-mentioned classes. His sections, orders, or secondary divisions, are forty-seven in number, and depend upon a variety of parts and circumstances. The principal of these are, the disposition, situation, and figure, of the flowers; the nature of the seed-vessel, or cover of the seeds; the situation of the radicle in the seed; the number of seed-lobes, or seminal leaves; the disposition of the leaves, and colour of the flowers. The lactescence too, or milkiness, which is observed in the compound flowers with flat florets, is made a characteristic distinction, and discriminates the first order of the twelfth class. Thus, in the first systematic arrangements, the characters of the classes only were borrowed from the parts of fructification; while those of the subaltern divisions were very numerous, and respected every part of the plant; but that such divisions might be perfect, they should be constituted, like the classes, from the modifications of a single part of the fructification.

The great object had in view by Morison, who comes next in order to Cæsalpinus, was to investigate the order of nature, not to fabricate an easy method of arranging of plants. Hence his system is devoid of uniformity, and clogged with a multiplicity of

of characters; his classes are frequently not sufficiently distinguished from one another, and the key of arrangement seems totally lost. He sets out with a division of plants, from their consistence, into ligneous or woody, and herbaceous. He founds his system on the fruit, the corollæ or blossoms, and the habit of the plants. His classes are as follow: 1. Trees. 2. Shrubs. 3. Under-shrubs. 4. Herbs climbing. 5. Herbs leguminous or papilionaceous. 6. Herbs podded. 7. Herbs tricapular or with three capsules. 8. Herbs with four or five capsules. 9. Herbs corymbiferous. 10. Herbs having a milky juice, or downy tops. 11. Herbs culmiferous, as grasses. 12. Herbs umbelliferous. 13. Herbs having three kernels. 14. Herbs having helmet-shaped flowers. 15. Herbs having many capsules. 16. Herbs berry-bearing. 17. Herbs called capillary plants, as the fern kind. 18. Anomalous or irregular herbs. Of these classes, the fourth and eighth possess no genuine distinctive character; nor are the ninth and tenth sufficiently distinguished; the fifteenth class is not sufficiently distinguished from the eighth, nor the sixteenth from the fourth. His sections or secondary divisions, which are one hundred and eight in number, arise from the figure and substance of the fruit; the number of seeds, leaves, and petals; the figure of the root; the direction of the stem; the colour of the flowers; the place of growth; and, in one class, from the medicinal virtues of some of the plants that compose it.

In 1682, our eminent countryman Ray, proposed his method to the world, two years after the publication of Morison's, which served in some measure as its basis. It consisted originally of the following twenty-five classes: 1. Trees. 2. Shrubs. 3. Herbs imperfect. 4. Herbs having no flowers. 5. Capillary plants. 6. Staminous herbs, having only the stamina. 7. Those having one naked seed. 8. Umbelliferous herbs

herbs. 9. Verticillated, annular, or ring-shaped ones. 10. Rough-leaved plants. 11. Stellated or star-shaped ones. 12. Apple-bearing herbs. 13. Berry-bearing herbs. 14. Herbs having many pods. 15. Monopetalous uniform, or regular herbs. 16. Monopetalous irregular, or having different forms. 17. Tetrapetalous, having large pods. 18. Tetrapetalous, having small pods. 19. Papilionaceous. 20. Pentapetalous herbs. 21. Corns. 22. Grasses. 23. Grass-leaved plants. 24. Bulbous-rooted plants. 25. Plants near akin to the bulbous. This method Ray carefully corrected and amended at different times; so that the plan of arrangement which now bears the name of that author, and was first published in 1700, is entirely different from what had appeared in 1682. It now consists of thirty-two classes. Their distinguishing marks are taken from the habit of the plants; their greater or less degree of perfection; their place of growth; the number of seed-lobes, or seminal leaves, petals, capsules, and seeds; the situation and disposition of the flowers, flower-cup, and leaves; the absence or presence of the buds, flower-cup, and petals; the substance of the leaves and fruit; the difficulty of classing certain plants. They are as follow: 1. Submarine, or sea-plants. 2. Fungi. 3. Mosses. 4. Capillary plants. 5. Those without petals. 6. Planipectalæ, or those with compound flowers, semisflosculous, or half-florets. 7. Those with compound flowers, radiated. 8. Those with compound flowers, flosculous, or with whole florets. 9. Plants with one seed. 10. Plants umbellated. 11. Those stellated or star-shaped. 12. Rough-leaved plants. 13. Plants verticillate or whirled. 14. Those with many seeds. 15. Apple-bearing herbs. 16. Berry-bearing herbs. 17. Those with many pods. 18. Monopetalous herbs. 19. Those with two and three petals. 20. Those with great and small, or long and short, pods. 21. Leguminous plants. 22. Pentapetalous

petalous ones. 23. Bulbs, and bulbous-like plants. 24. Stameneous ones, or those having only the stamina. 25. Anomalous plants, or those of an uncertain family. 26. The palms. 27. Trees without petals. 28. Trees with an umbilicated fruit. 29. Trees with fruit not umbilicated. 30. Trees with a dry fruit. 31. Trees with podded fruit. 32. Anomalous, or irregular, trees.

The distinction into herbs and trees with which Ray's method sets out, acknowledges a different, though not more certain, principle than that of Cæsalpinus and Morison. The former, in making this distinction, had an eye to the duration of the stem; the latter, to its consistence. Ray called in the buds as an auxiliary; and denominates trees, "all such plants as bear buds;" herbs, "such as bear none." But against this auxiliary there lies an unanswerable objection; namely, that, though all herbaceous plants rise without buds, yet all trees are not furnished with them; many of the largest trees in warm countries, and some shrubby plants in every country, being totally destitute of that scaly appearance which constitutes the essence of a bud. Hence it is obvious, that Nature has put no limits between a tree and a shrub, which is only a vulgar distinction. In other respects, it is also evident, that neither Mr. Ray's plan nor execution is in any degree calculated to facilitate the knowledge of plants. In fact, it seems to have been Ray's great object, no less than Morison's, to collect as many natural classes as possible; and these being separately investigated, a multiplicity of characters and steps was necessarily required to connect them: and hence the intricacy complained of in both these systems, which must always take place where the classes give rise to the connecting characters, and not the characters to the classes. The characters of the orders, or secondary divisions, in Ray's method, are no less multifarious than those of the classes.

They respect the place of growth of plants; their qualities; the figure of the stem; the number, situation, substance, and division, of the leaves; the situation and disposition of the flowers and calyx; the number and regularity of the petals; with the number and figure of the fruit. In his improved method, Ray has adopted Tournefort's characters of the genera, wherever his plan would permit. His general History of Plants contains 18,655 species and varieties. The third volume, which was not published till 1704, and was designed as a supplement to the two former, contains the plants discovered by Tournefort in the Levant, and by Camelli at Luzon, one of the Philippine islands. Ray's method was followed by Sir Hans Sloane, in his Natural History of Jamaica; by Petiver, in his British Herbal; by Dillenius, in his Synopsis of British Plants; and by Martyn, in his Catalogue of Plants that grow in the neighbourhood of Cambridge.

To Ray's original method succeeded that of Christopher Knaut, a German; which acknowledges the same principle, and is manifestly founded upon it. In his enumeration of the plants that grow round Halle in Saxony, published in 1687, he divides vegetables into seventeen classes, which have for their basis the size and duration of plants, the presence or absence of the petals, the disposition of the flowers, the substance of the fruit, the number of capsules or seeds, the number and figure of the petals, and the presence, absence, or figure, of the calyx. His classes are, 1. Herbs berry-bearing. 2. Monopetalous, or with one flower-leaf. 3. Tetrapetalous and regular, with four petals. 4. Tetrapetalous and irregular. 5. Pentapetalous, or with five petals. 6. Hexapetalous, or six petals. 7. Polypetalous, or many petals. 8. Multicapsular, or many capsules. 9. Naked seeds. 10. Solid, or not downy. 11. Downy seeds. 12. Without petals. 13. Stameneous, without petals

or;

or calyx. 14. Imperceptible. 15. Imperfect. 16. Trees. 17. Shrubs. The sections or subdivisions of the classes in Knaut's method are sixty-two in number; and arise from the figure of the stem and petals, the number of capsules and cells, their figure, the number of seeds and leaves, and situation of the flowers.

In 1696, a new method, proposed by Dr. Herman, professor of botany at Leyden, was published by Zumbac, who arranged it according to the plants contained in the public garden of Leyden. Rudbeckius the younger, in a dissertation published the same year, on the fundamental knowledge of plants, adopted Herman's method with a few inconsiderable variations. The classes of Dr. Herman are twenty-five in number. They are founded on the size and duration of the plants; the presence or absence of the petals and calyx; the number of capsules, cells, and naked seeds; the substance of the leaves and fruit; the form and consistence of the roots; the situation and disposition of the flowers, leaves, and calyx; and figure of the fruit. 1. Herbs having one naked seed and a simple flower. 2. Having one naked seed and a compound flower. 3. With two naked seeds, and stellated or star-shaped. 4. Two naked seeds, and umbelliferous. 5. Four naked seeds and rough leaves. 6. Four naked seeds, and verticillated or whirl-shaped. 7. With many naked seeds. 8. Having seed-vessels, bulbous and tricapular. 9. Having one seed-vessel. 10. With two seed-vessels. 11. With three seed-vessels. 12. With four seed-vessels. 13. With five seed-vessels. 14. Podded, which are always tetrapetalous. 15. Leguminous and papilionaceous. 16. With many capsules. 17. Having fleshy fruit, berry-bearing. 18. With fleshy fruit, apple-bearing. 19. Without petals, but having a calyx. 20. Without petals, chaffy, or staminous. 21. Without petals, calyx, chaff, or stamens, i. e. a naked anthera, as the mosses. 22. Trees with im-

perfect fructification, bearing catkins. 23. Trees with a fleshy fruit umbilicated. 24. Trees with a fleshy fruit not umbilicated. 25. Trees with a dry fruit. The classes in this method are subdivided into eighty-two sections or orders; which have for their basis the number of petals, seeds, capsules, and cells, the figure of the seeds and petals, and disposition of the flowers.

To the method of Dr. Herman succeeded that of Boerhaave, who filled the botanical chair of Leyden in 1709. His method is that of Herman, blended with part of the systems of Tournefort and Ray; and contains the following classes. 1. Herbs submarine, or sea-plants. 2. Imperfect land-plants. 3. Capillary plants, or the fern kind. 4. Many naked seeds. 5. Four naked seeds, and verticillated. 6. Four naked seeds, and rough leaves. 7. Four naked seeds, and four petals. 8. Plants having one seed-vessel. 9. Two seed-vessels. 10. Three seed-vessels. 11. Four seed-vessels. 12. Five seed-vessels. 13. Many seed-vessels. 14. Two naked seeds, and umbelliferous. 15. Two naked seeds, and star-shaped. 16. One naked seed, and a simple flower. 17. One naked seed, and compound flowers semisflosculous. 18. One naked seed, and compound flowers radiated. 19. One naked seed, and compound flowers corymbiferous. 20. One naked seed, and compound flowers flosculous. 21. Berry-bearing herbs. 22. Apple-bearing herbs. 23. Without petals. 24. One cotyledon, and having petals. 25. One cotyledon, and without petals. 26. Trees having one cotyledon. 27. Many podded. 28. Podded. 29. Tetrapetalous and cruciform. 30. Leguminous. 31. Having no petals. 32. Bearing catkins. 33. Monopetalous flowers. 34. Rosaceous flowers.

These thirty-four classes of Dr. Boerhaave are subdivided into 104 sections, which have for their characters, the figure of the leaves, stem, calyx, petals, and

and seeds; the number of petals, seeds, and capsules; the substance of the leaves; the situation of the flowers, and their difference in point of sex. By this method, Boerhaave arranged near 6000 plants, the produce of the botanical garden at Leyden, which he carefully superintended for the space of twenty years, and left to his successor, Dr. Adrian Royen, in a very flourishing state. Boerhaave's characters are derived from the habit or general appearance of plants combined with all the parts of fructification; so that, as Linnæus very justly observes, he was the first who employed the calyx, stamina, and style, in determining the genus. About seventeen new genera were established by this author; among others, the very splendid family of the protea and silver-tree, which, although partly described by Morison, had remained generally unknown till this period. His method was adopted by Emsling, a German, in a treatise intitled "The first Principles of Botany," published in octavo at Wolfenbuttle, in 1748.

Hitherto all the botanists had been intent upon investigating the nature of plants, rather than facilitating the arrangement of vegetables: therefore their methods were very intricate and perplexed; and their writings, however entertaining to the learned, could afford but little instruction to the young botanist. In 1690, however, Augustus Quirinus Rivinus, a German, professor of botany at Leipzig, relinquishing the pursuit of this method, and convinced of the insufficiency of characteristic marks drawn only from the fruit, attached himself to the flower, which, he was sensible, would furnish characters no less numerous, permanent, and conspicuous, than those drawn from the fruit. The calyx, petals, stamina, and style, which constitute the flower, are sufficiently diversified in point of number, figure, proportion, and situation, to serve as the basis of a mode of arrangement; yet all are not equally proper for this purpose. Ri-

vinus

vinus made use of the petals as the largest and most beautiful part, and that from which the flower itself is commonly characterized. His method consists of the following eighteen classes, which have for their basis the perfection and disposition of the flowers, and the regularity and number of the petals. 1. Regular monopetalous, or having one petal. 2. Dipetalous. 3. Tripetalous. 4. Tetrapetalous. 5. Pentapetalous. 6. Hexapetalous. 7. Polypetalous, or having many petals. 8. Irregular monopetalous. 9. Irregular dipetalous. 10. Irregular tripetalous. 11. Irregular tetrapetalous. 12. Irregular pentapetalous. 13. Irregular hexapetalous. 14. Irregular polypetalous. 15. Compound flowers of regular florets. 16. Compound flowers of regular and irregular florets. 17. Compound flowers of irregular florets only. 18. Incomplete or imperfect plants.

As Rivinus set out with the professed design of imparting facility to botany, he judged very properly in divesting his method of all extraneous matter, and rendering it as simple and uniform as the nature of the science would admit. The distinction into herbs and trees had been adopted by every writer on plants since the time of Aristotle. Rendered in some measure sacred by its antiquity, this distinction maintained a kind of importance to which it was by no means intitled. Rivinus was the first who in this matter dared to think for himself. He was early sensible of the inconveniencies to which those had submitted who employed it as a primary division; and therefore resolved at once to get rid of a distinction that is frequently uncertain, always destructive to uniformity, and in its nature repugnant to the genuine spirit of system, because totally unconnected with the parts of fructification. In the uniformity of its orders or secondary divisions, which are ninety-one in number, and acknowledge the fruit for their principle, Rivinus's method equals, perhaps excels, all that
went

went before it. Only three classes of his method were published by Rivinus himself. These were the eleventh, fourteenth, and fifteenth, which were offered to the public at different times, illustrated with very splendid figures. The method was completed and published entire by Heucher, in a work intituled *Hortus Wirtenbergensis*, printed in quarto at Wirtemberg in 1711.

Several German authors have followed Rivinus's method, either wholly or in part, without offering any considerable amendment. The principal of these are, Koenig, in a work on vegetables, published at Basil in 1696; Welsch, in his *Basis Botanica*, printed at Leipzig, in 8vo. in 1697; Gemeinhart, in a catalogue of plants published in 1725; Kramer, in a work intituled *Tentamen Botanicum*, published, at Dresden, in 1728, and afterwards reprinted, with additions, at Vienna, in 1744; and Hecker, in a Dissertation on Botany, published at Halle, in Saxony, in 1734. To these may be added Hebenstreit, an ingenious botanist, who in a *Treatise on Plants* published at Leipzig in 1731, just before his famous African expedition, established generical characters, which had hitherto been wanting in Rivinus's method.

The writers who have attempted to improve upon Rivinus's system, are Bernard Ruppius, Christopher Ludwig, and Christian Knaut. Ruppius, in his *Flora Jenensis*, published at Frankfort in 1718, has arranged the 1200 plants there described by a method partly Rivinus's and partly his own. It consists of seventeen classes, and sets out with the same divisions and subdivisions as that of Rivinus's; with this difference, that whereas in Rivinus's method all perfect flowers are divided into simple and compound, in Ruppius the division of regular and irregular flowers precedes that just mentioned, and simple and compound flowers are made subdivisions of the regular flowers only.

Christopher

Christopher Ludwig's method, which was published in 1737, and consists of twenty classes, differs but little from that of Rivinus. The author accompanied Hebenstreit on his expedition into Africa, and seems to have made plants his favourite study. The improvement, however, which he has made on Rivinus's plan, consists only in rendering it more universal, having enriched it with a multitude of genera collected from the works of Tournefort, Ray, Boerhaave, Dillenius, and other eminent botanists, whose generical characters he has likewise adopted. His plan of arrangement has been followed by two succeeding writers: M. Wedel, in a botanical essay, published in 1747; and three years after by M. Boeheimer in his catalogue of the plants in the garden of Leipzig.

The system of Christian Knaut is much more properly his own, and departs in a much greater degree from that of Rivinus, than either of the two former. The regularity and number of the petals furnished the classical divisions in Rivinus's method; in that of Knaut, number takes place of regularity; so that it is very properly termed by Linnæus, "The system of Rivinus inverted." This method was published in 1716; and sets out with a division into flowers which have one petal, and such as have more than one. It consists of the seventeen following classes: 1. Monopetalous uniform or regular. 2. Monopetalous difform or irregular. 3. Monopetalous compound uniform or regular. 4. Monopetalous compound difform or irregular. 5. Monopetalous compound uniform and difform together. 6. Dipetalous uniform or regular. 7. Dipetalous difform or irregular. 8. Tripetalous uniform or regular. 9. Tripetalous difform or irregular. 10. Tetrapetalous uniform or regular. 11. Tetrapetalous difform or irregular. 12. Pentapetalous uniform or regular. 13. Pentapetalous difform or irregular. 14. Hexapetalous uniform or

or regular. 15. Hexapetalous difform or irregular. 16. Polypetalous uniform or regular. 17. Polypetalous difform or irregular.

The sections or secondary divisions in Knaut's method are 121, and depend upon the internal divisions of the fruit; and upon this his divisions are somewhat singular. Every kind of fruit, whether pulpy or membranaceous, is termed by this author a *capsule*. Neither is the term restricted to fruits properly so called; it is extended also to those termed by botanists naked seeds, the existence of which Knaut absolutely denies. Agreeably to this opinion, capsules, he says, with respect to their consistence or substance, are of two sorts; pulpy, or membranaceous. The former correspond to the fruits of the apple, berry, and cherry, kind; the latter to the capsules properly so called, and naked seeds of other botanists. Again, with respect to their cells or internal divisions, capsules are either simple or compound. Simple capsules have an undivided cavity or a single cell; compound capsules are internally divided into two or more cells. With other botanists, the umbelliferous flowers bear two, the lip-flowers four, naked seeds; according to Knaut, the former produce two, the latter four, simple capsules. *Ranunculus*, *adonis*, *anemomy*, herb bennet, and some other plants, have their flowers succeeded by a number of naked seeds collected into an aggregate or head; each of these seeds passes with Knaut for a simple capsule; so that the whole is an aggregate of several capsules with an undivided cavity or single cell. In numbering the cells or internal divisions of the pulpy fruits, he has adopted a very singular method. Some fruits of the apple kind inclose a capsule that is divided into five membranaceous cells. It might then be very reasonably expected to find such fruits arranged with compound capsules of five cells: but, instead of this, the author whimsically enough combines in their arrangement

ment the idea both of a simple and compound capsule. The pulpy part is undivided; in other words, it is a simple capsule furnished with one cell; the compound capsule inclosed contains five cells, which added to that of the pulp make the number six; and thus these kinds of fruits are arranged with those having capsules of six cells. By the same kind of reasoning, the fruit of the dogwood, which is of the cherry kind, and contains a stone with two cells or cavities, is placed by Knaut among compound capsules with three cells; the pulp passing for one division, and the cavities of the stone or nut for the remaining two. This method of calculation is not the only singularity for which Knaut is remarkable. The essence of the flower is made by Ray, Tournefort, Rivinus, and most other botanists, to consist in the stamina and style. This position Knaut absolutely denies; and has established for a principle, that the flower is essentially constituted by the petals only. With him the flower-cup, stamina, and style, are of little account: their presence does not constitute a flower, if the petals are wanting; neither is their absence sufficient to destroy its existence, if the petals are present. From this it follows, 1. That there can be no flowers without petals: and, 2. That the regularity or irregularity of the flower can never depend on the stamina and style, which are only occasionally present, and no wise essential to its existence; both of which positions are evidently false to every botanical reader.

Since the time of Rivinus, no leading method in botany has appeared, except that of Tournefort, which immediately preceded the system of Linnæus. Tournefort sets out with reviving the distinction of plants into herbs and trees, which had been exploded by Rivinus. His system is founded on the regularity and figure of the petals, together with the two-fold situation of the receptacle of the flowers; his orders,

on the pistillum or calyx. The classes are, 1. Herbs with simple flowers monopetalous, and bell-shaped. 2. Simple flowers monopetalous, tunnel and wheel shaped. 3. Simple flowers monopetalous, labiated or lipped. 4. Simple flowers monopetalous, anomalous or irregular. 5. Simple flowers monopetalous, cruciform or cross-shaped. 6. Simple flowers polypetalous, and rosaceous or like a rose. 7. Simple flowers polypetalous, umbellated. 8. Simple flowers polypetalous, caryophyllaceous or clove-form. 9. Simple flowers polypetalous, liliaceous or lily-form. 10. Simple flowers polypetalous, papilionaceous or butterfly-form. 11. Simple flowers polypetalous, anomalous, or irregular. 12. Compound flowers, flosculous, tubular or whole florets. 13. Compound flowers semiflosculous, flat, or half-florets. 14. Compound flowers radiated like the spokes of a wheel. 15. Apetalous, having no petals. 16. No flower, but bearing seed. 17. No flower nor seed, in the vulgar estimation. 18. Trees with no petals, but bare stamina. 19. Trees with no petals bearing catkins. 20. Trees monopetalous. 21. Trees rosaceous. 22. Trees papilionaceous. The secondary divisions in Tournefort's method, which are 122 in number, have obtained the name of *sections*. Their general distinctions are founded principally upon the fruit, as those of the classes are upon the flower.

Tournefort's system hath been adopted by a vast number of botanical writers, of whom the most considerable are, Dr. William Sherard, who in 1769 published the first sketch of Tournefort's method, under the title of *Schola Botanices*, or a Catalogue of the Plants demonstrated by Dr. Tournefort in the Royal Garden at Paris. It was not till five years after, that the *Elementa Botanica*, a work which contains the rudiments and illustration of his method, was published by Tournefort himself. Father Plumier, termed by way of eminence the Tournefort

of America, published in 1703, at Paris, a description of American plants, which he arranged according to the system of Tournefort.—In this work he accurately characterized ninety-six new genera. Falugi, an Italian, has described, in Latin verse, all the genera of Tournefort, in a work intitled *Protopopæia Botanica*, published at Florence, 12mo. 1705. Several celebrated French academicians, particularly Marchant, Dodart, Nissole, Jussieu, and Vaillant, have occasionally paid their tribute of acknowledgment to this author, from the year 1700 to 1740. The other authors of note who have followed Tournefort's method, are, M. Petit, an ingenious French botanist; Johren, a German, author of a treatise published at Colberg in 1710, intitled *Vade-mecum Botanicum, seu Odegus Botanicus*; Feuillé, in his description of the plants of Chili and Peru, published at Paris in quarto, 1714; Christopher Valentin, a German, author of *Tournefortius Contractus*, published at Frankfort, in folio, 1715; Ripa, an Italian, in a work intitled *Historiæ Universalis Plantarum Conscribendi Propositum*, published in quarto, at Padua, in 1718; Michael Valentin, a German, in his *Viridarium Reformatum*, published in folio at Frankfort, in 1719; the celebrated Dillenius, professor of botany at Oxford, and author of several much-esteemed publications on botany, particularly the *Hortus Elthamensis*, and *History of Mosses*, in his *Flora Giffensis*, printed at Frankfort in 1719; Pontedera, an Italian, author of the delineation of a method which combines those of Tournefort and Rivinus, published at Padua, in his botanical dissertations, in 1720; Monti, an Italian, in a work published at Bologna in 1724, under the title of *Indices Plantarum Varii*; Lindem, a German, in his *Tournefortius Alsaticus*, first published in 1728; Signior Micheli, author of several curious discoveries respecting mosses and mushrooms, in his *Nova Genera Plantarum*,

Plantarum, published in folio at Florence in 1729; Elvebemes, a Swede, in a work published at Upsal in 1730; Fabricius, a German, author of a work intitled *Primitiæ Floræ Butisbacensis, seu Sex Decades Plantarum Rariorum*, published in 1743; Sadebati, an Italian, in his catalogue of the plants that grow in the neighbourhood of Rome, printed at Rome in 1745; and the ingenious Dr. Charles Alston, late professor of botany at Edinburgh, in his *Tyrocinium Botanicum*, published at Edinburgh in 1753.

Of all this numerous list of writers, Father Plumier and Pontedera alone have ventured to quit the track pointed out by Tournefort. The former, in his arrangement of American plants, has relinquished the distinction into herbs and trees; but the latter has attempted more considerable variations. His classes are, 1. Uncertain. 2. Having no flowers. 3. Without buds, imperfect plants. 4. Anomalous or irregular. 5. Labiated. 6. Bell-shaped. 7. Saucer-shaped. 8. Wheel-shaped. 9. Tunnel-shaped. 10. Flosculous. 11. Semiflosculous. 12. Radiated. 13. Irregular. 14. Papilionaceous. 15. Liliaceous. 16. Caryophyllaceous. 17. Cruciform, or cross-shaped. 18. Umbellated. 19. Staminous, or with naked stamina. 20. Bearing buds, apetalous, or without petals. 21. Bearing buds, irregular. 22. Bearing buds, bell-shaped. 23. Bearing buds, wheel-shaped. 24. Bearing buds, tunnel-shaped. 25. Bearing buds, papilionaceous. 26. Bearing buds, rosaceous.

Besides all these systems, there have been invented two others, founded upon the *calyx*. The first of these was the invention of Peter Magnol, a celebrated professor of botany at Montpellier, and published in 1720, five years after the author's death. The other was delineated by Linnæus, and published in his *Classes Plantarum*, in 1738, three years after the publication of the sexual system. Magnol distinguishes

guishes two kinds of calyx; one external, which envelops and sustains the flower, and is the flower-cup properly so called; the other internal, which is the seed-vessel or fruit. According to this idea, all plants, whether herbaceous or woody, are furnished with either the external calyx only, or with both. His classes are, 1. Herbs with the calyx external, including a flower unknown. 2. Calyx external, including a flower staminous. 3. Calyx external, including a flower monopetalous. 4. Calyx external, including a flower polypetalous. 5. Calyx external, including a flower compound. 6. Calyx external, supporting a flower monopetalous. 7. Calyx external, supporting a flower polypetalous. 8. Calyx internal only, which is the corolla. 9. Calyx external and internal, flower monopetalous. 10. Calyx external and internal, flower with two and three petals. 11. Calyx external and internal, tetrapetalous. 12. Calyx external and internal, polypetalous. 13. Trees with the calyx external only. 14. Calyx internal only. 15. Calyx external and internal both.

The characters of the orders, or secondary divisions, in Magnol's method, are derived chiefly from the figure of the calyx, petals, and seeds; from the disposition of the flowers, from the number of the petals, and substance of the fruit. Fifty-five sections or orders arise from the combination of these characters with those of the classes; and these are again subdivided into genera, which possess this singularity, that, in place of distinctive characters hitherto employed, they exhibit complete descriptions of all the parts of fructification of one or two species of each genus.

To these multiplied and laborious endeavours to form a rational method of classing plants, succeeded the system of Linnæus, which is unquestionably more conformable to the true principles of philosophy than all those which preceded it. Yet he strenuously insists that

that there is an unerring and invariable *natural method*, by which Creative Wisdom has ordained that vegetable productions should be connected by a natural affinity, and yet be distinct from each other; but he modestly owns his inability to detect this natural method, after long and repeated researches for that purpose. He has nevertheless framed a *Natural Order of Plants*, by placing together under appropriate names, all those which appear to have a natural similitude or affinity; and he importunes succeeding botanists diligently to search after this natural method, as *Nature's own system*. "That this system," says he, "is no chimera, will satisfactorily appear from hence, that all plants, of what order soever, show an affinity to some others; and hence, if this affinity, or the links of this natural chain, could be once made out and connected, not only the virtues of a great number of species may be ascertained, but we may know with certainty how to find a proper succedaneum for plants which cannot easily be had."

Sir John Hill, in his *Vegetable System*, endeavours to detect this natural order, by classing plants according to their internal structure. "Perhaps," says he, "upon the foundation of a true anatomy of plants, a natural method may be established: for it is certain that the forms of all the external parts of vegetables depend on the disposition of the internal; and all their differences are founded there. On the different inner structure of the vegetable body, under certain courses of its vessels, evidently depend the differences which characterize the seven first families, to the distinctions of which all classes are subordinate; and as these original distinctions are truly natural, we may here begin very safely. The seven families are these: 1. The mushrooms. 2. The *algæ*, or foliaceous sea and land plants. 3. The mosses. 4. The ferns. 5. The grasses. 6. The palms. 7. The common race of plants. Their distinctions one from another are these:

"1. The

"1. The mushrooms are fleshy, and are destitute of leaves and visible flowers. 2. The algæ are merely foliaceous, the entire plant consisting of a leafy matter without other visible parts. 3. The mosses have processes of the inner rind for leaves. 4. The ferns consist of a single leaf raised on a stalk, and bear their flowers upon its back. 5. The grasses have jointed stalks and undivided leaves, and husks to hold the seeds. 6. The palms have a simple trunk, with leaves only on the top, and have the flowers and fruit in divided ears." The seventh class, which he calls the *common race of plants*, are such as have their roots, leaves, stalks, flowers, and fruits, distinct and obvious; and have not the characters of any of the other six families. To this natural method, his artificial one, consisting of forty-three classes, and which takes up the whole of his voluminous work, is designed only as an index; but as this is universally allowed to be inferior to Linnæus's natural method, it is needless for us to investigate it further. But as the natural order of Linnæus is followed and adopted by Professor Martyn, and many other of the most respectable authors, we should not deem our treatise complete, without giving it a place, as follows:

LINNÆUS'S NATURAL ORDER of PLANTS.

1. **PALMÆ.** These are perennial, and mostly of the shrub and tree kind. The stem is in height from two to one hundred feet and upwards: and the roots form a mass of fibres which are commonly simple and without any ramifications. This order includes the following genera: *Areca*, the faufel-nut, or cabbage-tree; *Borassus*, Malabar palm, called ampana, carimpana, and palmaira-tree; *Caryota*, palm with doubly winged leaves, called sehunda-pana; *Chamærops*, dwarf palm, or palmetto; *Cocos*, cocoa-nut tree; *Corypha*, mountain-palm with largest leaves, called todda-pana; *Cycas*, todda-pana; *Elais*; *Elate*, wild Malabar

Malabar palm, called katou-indel; Phoenix, date-tree; Zamia; Hydrocharis, frog's-bit; Stratiotes, water-soldier; Vallisneria.

2. PIPERITÆ. These plants are mostly herbaceous and perennial. They consist of pepper, and a few genera which agree with it in habit, structure, and sensible qualities, particularly the latter. The genera contained in this order are, Ambrosinia; Arum, cuckow-pint, or wake-robin; Calla, African arum; Dracontium, dragons; Pothos, scunck-weed; Zostera, grass-wrack; Acorus, sweet-rush, or calamus aromaticus; Orontium, floating arum; Piper, pepper; Saururus, lizard's-tail.

3. CALAMARIÆ, from *calamus*, (Lat.) a reed. In this class the base of the leaf, which embraces the stalk like a glove, has no longitudinal aperture. The stalk is generally triangular, and without knots. The flowers have no petals. By these three particulars this order is easily distinguished from the family of the grasses, to which it is nearly allied. The genera contained in this natural order are, Cyperus, cypress-grass; Eriophorum, cotton-grass; Schœnus, base cypress; Scirpus, rush-grass; Carex, sedge, or cypress-grass; Sparganium, burr-reed; Typha, cat's-tail, or reed-mace.

4. GRAMINÆ. This natural order consists of the numerous and natural family of the grasses, viz. Agrostis, bent-grass; Aira, hair-grass; Alopecurus, fox-tail grass; Anthoxanthum, vernal grass; Aristida, oat-grass; Arundo, reed; Avena, oats; Bobartia; Briza, quaking-grass; Bromus, brome-grass; Cinna; Cornucopiæ, horn-of-plenty grass; Cynosurus, dog's-tail grass; Dactylis, cock's-foot grass; Elymus, lyme-grass; Festuca, fescue-grass; Hordeum, barley; Lagurus, hare's-tail grass; Lolium, darnel; Lygeum, hooded matweed; Melica, melic, or rope-grass; Milium, millet; Nardus, mat-grass; Oryza, rice; Panicum, panic-grass; Paspalum; Phalaris; canary-grass; Phleum,

Phleum, cat's-tail grass; Poa, meadow-grass; Saccharum, sugar-cane; Secale, rye; Stipa, winged spike-grass; Triticum, wheat; Uniola, sea-side oats of Carolina; Coix, Job's-tears; Olyra; Pharus; Tripsacum; Zea, Turkey wheat, or Indian corn; Zizania, water-oats, or tare-grass; Ægilops, wild fescue-grass; Andropogon, beard-grass; Apluda; Cenchrus, hedgehog-grass; Holcus, Indian millet; Ischæmum.

5. *TRIPETALOIDEÆ*, from *tres*, three, and *petalum*, a petal. These plants have no very striking characters, and are nearly allied to the grasses. All the genera of this order, however, are not tripetaloid. The genera are, Alisma, water-plantain; Aphyllanthes; Butomus, flowering-rush, or water-gladiolus; Calamus; Flagellaria; Juncus, rush; Sagittaria, arrow-head; Scheuchzeria, lesser flowering-rush; and Triglochin, arrow-headed grass.

6. *ENSATÆ*, from *ensis*, a sword; the leaves of the plants of this order being sword-shaped. The genera are, Antholyza; Callisia; Commelina, day-flower; Crocus, saffron; Eriocaulon, net-wort; Ferraria; Gladiolus, corn-flag; Iris, flower de luce; Ixia; Moræa; Pontederia; Sisyrinchium; Tradescantia, Virginian spider-wort, or flower of a day; Wachendorfia; Xyris.

7. *ORCHIDEÆ*. The roots of many of these plants are composed of one or more fleshy tubercles or knobs, attached to the lower part of the stem, and sending forth fibres from the top. Those of orchis bear an obvious resemblance to the scrotum in animals, from which circumstance the genus has derived its name. The genera are, Arethusa; Cypripedium, ladies'-slipper, Epidendrum, vanilla, or vanelloe; Limodorum, base hellebore; Ophrys, bee-flower, bird's-nest, or tway-blade; Orchis, butterfly-flower; Satyrium, lizard-flower; Serapias, helleborine, or base hellebore.

8. *SCITAMINEÆ*, from *scitamentum*, a dainty. This class

class consists of beautiful exotic plants, all natives of very warm countries. Some of them furnish exquisite fruits; but, though the plants rise very high, they are perennial only by their roots. Those which have only one filament, have in all their parts an aromatic odour, and an acrid or poignant taste; qualities, however, possessed in a much greater degree by the roots, which are hot and resinous. The genera are, *Alpinia*; *Amomum*, ginger; *Canna*, Indian flowering-reed; *Costus*; *Curcuma*, turmeric; *Kæmpferia*; *Maranta*, Indian arrow-root; *Musa*, banana, or plantain-tree; *Thalia*.

9. *SPATHACEÆ*, so called because their flowers are protruded from a *spatha*, or sheath. They are nearly allied in habit and structure to the liliaceous plants, from which they are chiefly distinguished by the *spatha* out of which their flowers are protruded. The genera contained in this order are, *Allium*, garlic, onion, &c. *Amaryllis*, lily-daffodil; *Bulbocodium*, mountain-saffron; *Colchicum*, meadow-saffron; *Crinum*, asphodel-lily; *Galanthus*, snow-drop; *Gethyllis*; *Hæmanthus*, blood-flower; *Leucoium*, greater snow-drop; *Narcissus*, daffodil; *Pancratium*, sea-daffodil.

10. *CORONARIÆ*. These plants are herbaceous, perennial, and from one inch to fifteen feet high. The genera included in this natural order are, *Albuca*, base star of Bethlehem; *Cyanella*; *Fritillaria*, fritillary, or crown imperial; *Helonius*; *Hyacinthus*, hyacinth; *Hypoxis*, base star-flower; *Lilium*, lily; *Melanthium*, star-flower; *Ornithogalum*, star of Bethlehem; *Scilla*, squill; *Tulipa*, tulip; *Agave*, American aloe; *Aletris*, base aloe; *Aloe*, aloe; *Anthericum*, spider wort; *Asphodelus*, asphodel, or king's-spear; *Bromelia*, ananas, or pine-apple; *Burmannia*; *Hemerocallis*, day-lily, or lily-asphodel; *Polyanthes*, tuberoſe; *Tillandsia*; *Veratrum*, white hellebore; *Yucca*, Adam's needle. With respect to the powers of the plants of this order, it may be affirmed in general,

that such as have little taste or smell, as the roots of tulip, and star of Bethlehem, are perfectly innocent; whilst those which have a heavy nauseous smell, as squill, hyacinth, crown-imperial, and spider-wort, frequently prove noxious.

11. SARMENTOSÆ, from *sarmentum*, a long shoot. This order consists of plants which have climbing stems and branches, like the vine. These plants are far from being a true natural assemblage; in fact they scarcely agree in a single circumstance, except that expressed in the title, which is far from being peculiar to this order. The genera are these, *Alstroemeria*; *Aristolochia*, birthwort; *Asarum*, asarabacca; *Asparagus*, sparrowgrass; *Centella*; *Cissampelos*; *Convallaria*, lily of the valley; *Cytinus*, hypocistis; *Dioscorea*, Indian yam; *Erythronium*, dog's-tooth violet; *Gloriosa*, superb lily; *Medeola*, climbing African asparagus; *Menispermum*, moon-feed; *Paries*, true-love, or one-berry; *Rajania*; *Ruscus*, butcher's-broom, or knee-holly; *Smilax*, rough bind-weed; *Tamus*, black bryony; *Trillium*, three-leaved nightshade, or herb true-love of Canada; *Uvularia*.

12. HOLERACEÆ, from *holus*, pot-herbs. This order consists of plants which are used for the table, and enter into the economy of domestic affairs; it contains trees, shrubs, perennial and annual herbs. The genera contained in this order are, *Anabasis*, berry-bearing glass-wort; *Anacardium*, acajou, or cashew-nut; *Atraphaxis*; *Bafella*, Malabar nightshade; *Beta*, beet; *Blitum*, blite, or strawberry spinach; *Bucida*; *Calligonum*; *Callitriche*, star-headed water-chickweed; *Camphorosma*; *Chenopodium*, goose-foot, or wild orach; *Coccoloba*, sea-side grape; *Corispermum*, tickseed; *Heisteria*; *Herniaria*, rupture-wort; *Illecebrum*, mountain knot-grass, or whitlow-grass; *Laurus*, bay, cinnamon, camphire, sassafras, and benjamin, tree; *Mimusops*; *Petiveria*, Guinea-ben weed; *Polycnemum*; *Polygonum*, knot-grass, bistort;

bistort; Rheum, rhubarb; Rhizophora, mangrove, or candle of the Indians; Rivina; Rumex, dock; Salicornia, jointed glass-wort, or salt-wort; Salsola, glass wort; Tinus; Winterania; Atriplex, orach; Axyris; Begonia; Ceratocarpus; Nyssa, the tupelo-tree; Spinacia, spinach.

13. **SUCCULENTÆ**, from *succus*, juice. This order consists of flat, fleshy, and juicy, plants, most of them ever-greens. They are astringent, refreshing, and very wholesome. The genera are, Aizoon; Cactus, melon thistle, torch-thistle, Indian fig; Galenia, Cape jessamine; Mesembryanthemum, fig-marigold; Neurada; Reaumuria; Tamarix, tamarisk; Tetragonia; Cotyledon, navel-wort; Crassula, lesser orpine; Penthorum; Rhodiola, rose-root; Sedum, lesser house-leek, or stone-crop; Sempervivum, houseleek; Septas; Suriana; Tillea, small annual houseleek; Claytonia; Nama; Portulaca, purslane; Sesevium; Trianthema, horse-purslane; Adoxa, tuberous moschatel, or hollow-root; Chrysosplenium, golden saxifrage; Hydrangea; Mitella, base American sanicle; Saxifraga, saxifrage; Tiarella.

14. **GRUINALES**, from *grus*, a crane. These consist of geranium, vulgarly called crane's-bill, and a few other genera which Linnæus considers as allied to it in their habit and external structure. This order furnishes both herbaceous and woody plants; and the genera included in it are, Aldrovanda; Avernhoa; Drosera, sundew; Fagonia; Geranium, crane's-bill; Guaiacum, lignum vitæ, or pockwood; Linum, flax; Oxalis, wood-forrel; Quassia, simarouba bark; Tribulus, caltrops; Zygophyllum, bean-caper.

15. **INUNDATÆ**. The plants of this order are aquatic, of low stature, herbaceous, and mostly perennial. The roots are fibrous. The stem is generally wanting. In its place is an assemblage of leaves, which wrapping or enfolding each other mutually form a sheath; and from the middle of this sheath is produced

duced the footstalk of the flower. The leaves are sometimes alternate, sometimes placed in whirls round the stem. The genera are, *Ceratophyllum*, hornwort; *Elatine*, water-wort; *Hippuris*, mare's-tail; *Myriophyllum*, water-milfoil; *Potamogeton*, pondweed; *Proserpinaca*; *Ruppia*, sea or tassel grass; *Zannichellia*, triple-headed pondweed.

16. *CALYCIFLORÆ*, from *calyx*, the flower-cup, and *flos*, the flower; consisting of such plants as have the stamina (the flower) inserted into the calyx. All the plants of this order are of the shrub and tree kind. In this order are only four genera, viz. *Elæagnus*, oleaster, or wild olive; *Hippophaë*, base rhamnus, or sea buckthorn; *Osyris*, poet's cassia; *Trophis*. The last genus is only to be found in the improved editions of Linnæus.

17. *CALYCANTHMEÆ*, from *calyx*, the flower-cup, and *anthos*, the flower; consisting of plants, which, among other characters, have the corolla and stamina inserted in the calyx. This order furnishes trees and shrubs, and annual, biennial, and perennial, herbs; but the herbaceous annuals are by much the most numerous. The genera are, *Epilobium*, willow-herb, or French willow; *Gaura*, yellow Virginian loose-strife; *Isnardia*; *Jussieua*; *Ludvigia*; *Melastoma*, American gooseberry-tree; *Mentzelia*; *Oenothera*, tree primrose; *Ammannia*; *Frankenia*, sea-heath; *Glaux*, sea-chickweed, or milkwort, and black saltwort; *Grifflea*; *Lythrum*, willow-herb, or purple loosestrife; *Osbeckia*, gold rose feather; *Peplis*, water-purflane; *Rhexia*, soap-wood.

18. *BICORNES*, from *bis*, twice, and *cornu*, a horn; plants whose antheræ have the appearance of two horns. The plants of this order are all of the shrub and tree kind. The genera contained in this natural order are, *Blæria*; *Azalea*, American upright honeysuckle; *Myrsine*, African box; *Erica*, heath; *Vaccinium*, whortle, or bilberries; *Andromeda*; *Arbutus*,

rus, strawberry-tree; Clethra; Epigea, trailing arbutus; Gualtheria; Kalmia, dwarf-laurel of America; Ledum, marsh cistus, or wild rosemary; Pyrola, winter-green; Rhododendrum, dwarf rosebay; Rhodora; Royena, African bladder-nut; Garcinia, mango-stan; Halefia, snowdrop-tree; Styrax, storax-tree; Citrus, citron, orange, lemon; Diospyrus, Indian date-plum. The appearance of the horned antheræ, which has given name to this order, is not very conspicuous, unless in the following genera: Whortle-berries, heath, strawberry-tree, dwarf rosebay, and trailing arbutus.

19. *HESPERIDÆ*, from the *Hesperides*, whose orchards are said to have produced golden apples. The plants of this order are of the shrub and tree kind, and mostly evergreen. It includes the following genera: Caryophyllus, clove-tree; Eugenia, pomme-rose, or yamboo; Myrtus, myrtle, and all-spice or pimento; Philadelphus, mock orange, or syringa; Psidium, guayava, or bay-plum.

20. *ROTACÆ*, from *rota*, a wheel, consists of plants with one wheel-shaped petal without a tube. These resemble in quality those of the order of *Preciæ*, to which they are in all respects very nearly allied; but very few of them can be said in strict propriety to possess the character specified in the title. The genera are, Anagallis, pimpernel; Centunculus, base pimpernel; Chironia; Exacum; Gentiana, gentian, or fellwort; Lyfimachia, loose-strife; Phlox, lychnidea, or base lychnis; Sarothra, base gentian; Swertia, marsh gentian; Trientalis, winter-green with chickweed flowers; Ascyrum, St. Peter's wort; Cistus, rock-rose; Hypericum, St. John's wort.

21. *PRECIÆ*, from *precius*, early. These consist of primrose, an early flowering plant, and some others which agree with it in habit and structure, though not always in the character or circumstance expressed in the title. These plants, which possess no striking uniform

form characters, are, in general, innocent in their quality; yet the root of fowbread is dangerous, if taken internally. The genera are, *Androsace*; *Aretia*; *Cortusa*, bear's-ear sanicle; *Cyclamen*, fowbread; *Diapensia*; *Dodecatheon*, Virginian cowslip; *Primula*, primrose, and auricula; *Soldanella*, soldanel; *Limnifolia*, least water plantain; *Hottonia*, water milfoil, or water violet; *Menyanthes*, bogbean, or marsh-trefoil; *Samolus*, round leaved water pimpernel.

22. *CARYOPHILLEÆ*. All the plants of this order are herbaceous, and mostly annual. They are innocent in their quality, abound in a watery phlegm, and have bitter seed. The genera are, *Agrostemma*, campion, or wild lychnis; *Cucubalus*, berry-bearing chickweed; *Dianthus*, clove July-flower, carnation, and pink; *Drypis*; *Gypsophila*; *Lychnis*, campion; *Saponaria*, soap-wort; *Silene*, viscous campion; *Velezia*; *Alfina*, chickweed; *Arenaria*, sandwort; *Buffonia*, toad-grass; *Cerastium*, mouse-ear chickweed; *Cherleria*; *Glinus*; *Holosteum*; *Lælingia*; *Mœhringia*, mountain chickweed; *Polycarpon*; *Sagina*; pearlwort; *Spergula*, spurrey; *Stellaria*, great chickweed; *Minuartia*; *Mollugo*, African chickweed; *Ortega*; *Pharnaceum*; *Queria*. To this order have been annexed, somewhat improperly indeed, two other genera, which cannot be arranged under any of the foregoing sections: *Polypremum*, Carolina flax; and *Scleranthus*, German knot-grass, or knawel: the former has a calyx of four pieces, and one wheel-shaped petal; the latter a hollow calyx of one piece, and no petals.

23. *TRIHLATÆ*, from *tres*, three, and *hilum*, an external mark on the seed; consisting of plants with three seeds, which are marked distinctly with an external cicatrix or scar, where they were fastened within to the fruit. The genera are, *Melia*, bead-tree; *Trichilia*; *Acer*, maple; *Æsculus*, horse-chestnut; *Banisteria*; *Malpighia*, Barbadoes cherry; *Triopteris*; *Cardiospermum*;

Cardiospermum, heart-feed, or heart-pea; *Paullinia*, supple jack; *Sapindus*, soap-berry; *Staphylæa*, bladder-nut; and *Tropæolum*, Indian cress.

24. **CORYDALES**, from *corvus*, a helmet, consist of plants which have irregular flowers, somewhat resembling a helmet or hood. These plants are mostly herbaceous and perennial. The genera are, *Epimedium*, barrenwort; *Hypecoum*; *Leontice*; lion's-leaf; *Melanthus*, honey-flower; *Pinguicula*, butter-wort, or Yorkshire sanicle; *Utricularia*, water-milfoil; *Fumaria*, fumitory; *Impatiens*, balsam, or female balsamine; *Monniera*.

25. **PUTAMINEÆ**, from *putamen*, a shell, consist of a few genera of plants allied in habit, whose fleshy seed-vessel or fruit is frequently covered with a hard woody shell. Most of these plants are acrid and penetrating; and yield, by burning, a great quantity of fixed alkali. The names of the genera contained in this order are, *Capparis*, caper-bush; *Cleome*, base mustard; *Cratæva*, garlic-pear; *Crescentia*, calabash-tree; *Marcgravia*; *Morisonia*.

26. **MULTISILIQUÆ**, from *multus*, many, and *siliqua*, a pod, consist of plants which have more seed-vessels than one. From the etymology of the term, one would naturally imagine that the seed-vessels in question were of that kind called by Linnæus *siliqua*, or pod: but the fact is, that not a single plant of this order bears pods; the greater part having many dry capsules, and the remainder being furnished properly with no seed-vessel, but bearing numerous distinct seeds. This order includes the following genera, viz. *Aconitum*, monk's-hood, or wolf's-bane; *Aquilegia*, columbine; *Delphinium*, larkspur; *Pæonia*, peony; *Dictamnus*, fraxinella, or white dittany; *Peganum*, wild Syrian rue; *Ruta*, rue; *Adonis*, adonis, or pheasant's-eye; *Caltha*, marsh-marigold; *Garidella*, fennel-flower of Crete; *Helleborus*, hellebore; *Isopyrum*; *Myosurus*, mouse-tail; *Nigella*, fennel-flower,

or devil in a bush; *Ranunculus*, crowfoot; *Trollius*, globe ranunculus, or locker gowls; *Aëta*, herb-christopher, or bane-berries; *Anemone*, wind-flower; *Atragene*; *Clematis*, virgin's bower; *Thalictrum*, meadow-rue.

27. *RHOEADÆ*, consisting of poppy, and a few genera which resemble it in habit and structure. These plants, upon being cut, emit plentifully a juice, which is white in poppy, and yellow in the others. With respect to their virtues, the juice is narcotic, their seeds less so, their roots aperient. Applied externally, they are slightly corrosive. The genera are, *Argemone*, prickly poppy; *Bocconia*, tree-celandine; *Chelidonium*, celandine; *Papaver*, poppy, *Podophyllum*, duck's-foot, or May-apple; *Sanguinaria*, puccoon, or blood-root.

28. *LURIDÆ*, consist of plants whose appearance seems to indicate something baleful and noxious in their natural quality. Most of these plants are herbaceous and perennial. The genera are, *Atropa*, deadly nightshade; *Browallia*; *Capficum*, Guinea pepper; *Catesbæa*, lily-thorn; *Celsia*; *Cestrum*, base jessamine; *Datura*, thorn-apple; *Digitalis*, fox-glove; *Ellisia*; *Hyoscyamus*, henbane; *Lycium*, box-thorn; *Nicotiana*, tobacco; *Pedaliium*; *Physalis*, alkekengi or winter-cherry; *Sesamum*, oily purging grain; *Solanum*, nightshade, potatoe, &c. *Strychnos*, poison-nut; *Verbascum*, mullein.

29. *CAMPANACEÆ*, from *campana*, a bell; plants with bell-shaped flowers. The plants of this order are herbaceous and perennial, viz. *Campanula*, bell-flower; *Convolvulus*, bindweed; *Evolvulus*; *Ipomœa*, quamoclit, or scarlet convolvulus; *Phyteuma*, rampions; *Polemonium*, Greek valerian, or Jacob's ladder; *Roella*; *Trachelium*, blue umbelliferous throat-wort; *Jalione*, rampions with scabious heads, or sheep-scabious; *Lobelia*, cardinal flower; *Viola*, violet, and heart's-ease.

30. *CONTORTÆ*,

30. *CONTORTÆ*, from *con*, together, and *torqueo*, to twist; consist of plants which have a single petal that is twisted or bent towards one side. This order consists of trees, shrubs, and fat succulent plants, some of which retain their leaves during the winter. The herbaceous vegetables in this order are generally perennial. The genera are, *Cerbera*; *Echites*, savanna flower; *Gardenia*, Cape jessamine; *Genipa*; *Microcnemum*; *Nerium*, oleander, or rose-bay; *Periploca*, Virginian silk; *Rauwolfia*; *Tabernæmontana*; *Vinca*, periwinkle; *Apocynum*, dog's-bane; *Asclepias*, swallow-wort; *Cameraria*; *Ceropegia*; *Cynanchum*, base dog's-bane; *Plumeria*; red jessamine; *Stapelia*, African swallow-wort. The plants of this order, abounding in a milky juice, are most of them deemed poisonous; repeated observations having established this aphorism, That milky plants, except those of the plain compound flowers, are generally of a baneful nature.

31. *VEPREULÆ*, from *vepres*, a briar or bramble; consist of plants resembling the daphne, dirca, gnida, &c. but which, however, do not constitute a true natural assemblage. The genera belonging to this order are, *Dais*; *Daphne*, mezereon, or spurge laurel; *Dirca*, leatherwood; *Gnidia*; *Lachnæa*; *Passerina*, sparrow-wort; *Quisqualis*; *Stellera*, German ground-sel, or *Tragus's* sparrow-wort; *Thesium*, basetoad-flax.

32. *PAPILIONACEÆ*, plants that have papilionaceous flowers, i. e. somewhat resembling a butterfly in shape; of which number are all the leguminous vegetables. The plants of this order are of a very different duration; some of them being herbaceous, and those either annual or perennial; others woody vegetables of the shrub and tree kind, a few of which rise to the height of seventy feet and upwards. The genera are these: *Anagyris*, stinking bean-trefoil; *Sophora*; *Abrus*, Jamaica wild liquorice; *Amorpha*, base indigo; *Anthyllis*, kidney-vetch, or lady's-finger;

Arachis, earth or ground nut; Alpalathus, African broom; Borbonia; Crotalaria, rattle-wort; Ebenus, ebony of Crete; Erythrina, coral-tree; Genista, single-seeded broom; Lupinus, lupine; Nissolia; Ononis, anonis, or rest harrow; Pitcidia, dogwood tree; Pterocarpus, red sanders; Spartium, broom; Ulex, furze, or whins; Æschynomene, base sensitive plant; Astragalus, liquorice-vetch, milk vetch, or goat's-thorn; Biserrula; base hatchet-vetch; Cicer, chick-pease; Clitoria; Colutea; bladder senna; Coronilla, jointed podded colutea; Cytisus, laburnum, or base tree-trefoil; Dolichos, cowitch; Ervum, lentils; Galea, goat's-rue; Geoffroya, base cabbage-tree; Glycine, Carolina kidney-bean tree; Glycyrrhiza, liquorice; Hedyсарum, French honeysuckle; Hippocrepis, horse-shoe vetch; Indigofera, indigo; Lathyrus, chichling vetch, or everlasting-pea; Lotus, bird's-foot trefoil; Medicago, snail and moon trefoil, lucerne; Ornithopus, bird's-foot; Orobus, bitter vetch; Phaca, base milk-vetch; Phaseolus, kidney-bean, or French-bean; Pisum, pea; Pforalea; Robinia, false acacia, Scorpiurus, caterpillar; Trifolium, trefoil; Trigonella, fenugreek; and Vicia, vetch, bean, tare, &c.

33. LOMENTACEÆ, from *lomentum*, a colour used by painters. Many of these plants furnish beautiful tinctures, and some of them are much used in dying. They very much resemble the last order. The genera are, Adenantha, base flower-sence; Baubinia, mountain-ebony; Cæsalpina, brasiletto; Cassia, wild senna; Ceratonia, carob-tree, or St. John's bread; Cercis, Judas-tree; Gleditsia, honey-locust, or triple-thorned acacia; Guilandina, bonduc, or nickar-tree; Hamatoxylon, logwood; Hymenæa, locust-tree, or courbaril; Mimola, sensitive plant, acacia, &c. Parkinsonia; Poinciana, Barbadoes flower-sence, or Spanish carnation; and Polygala, milkwort.

34. CUCURBITACEÆ, from *cucurbita*, a gourd, consist

consist of plants which resemble the gourd in external figure, habit, virtues, and sensible qualities. The plants of this order, which generally climb, and have long diffused branches, are mostly herbaceous and perennial. The genera are, *Gronovia*; *Melothria*, small creeping cucumber; *Passiflora*, passion-flower; *Anguria*; *Bryonia*, bryony; *Cucumis*, cucumber, and melon; *Cucurbita*, gourd, or pompion; *Elatarium*, spring-gourd; *Feuillea*; *Momordica*, male balsam-apple; *Sicyos*, single-seeded cucumber; and *Trichosanthes*, serpent-cucumber.

35. *SENTICOSÆ*, from *sentis*, a briar or bramble, consist of the rose, bramble, and other plants which resemble them in port and external structure. The genera are, *Agrimonia*, agrimony; *Alchemilla*, lady's-mantle; *Aphanes*, parsley-piert, *Comarum*, marsh-cinquefoil; *Dryas*; *Fragaria*, strawberry; *Geum*, avens, or herb-bennet; *Potentilla*, cinquefoil; *Rosa*, rose; *Rubus*, raspberry, and bramble; *Sibbaldia*; and *Tormentilla*, tormentil. These plants are very nearly allied in form, habit, and structure, to those of the natural order *Pomaceæ*.

36. *POMACEÆ*, from *pomum*, an apple, consist of those which have a pulpy esculent fruit, of the apple, berry, or cherry, kind. The plants of this order, which furnish many of our most esteemed fruits, are mostly of the shrub and tree kind. The genera are named thus: *Cratægus*, wild service-thorn; *Mespilus*, medlar; *Pyrus*, apple and pear; *Ribes*, currant-tree; *Sorbus*, service-tree; *Spiræa*, *spiræa frutex*, spiked willow, drop-wort; *Punica*, pomegranate; *Amygdalus*, almond-tree, peach, nectarine, &c. *Chrysobalanus*, cocoa-plum; and *Prunus*, plum, apricot, cherry.

37. *COLUMNIFERÆ*, from *columna*, a pillar, and *fero*, to bear, consist of plants whose stamina and pistillum have the appearance of a column or pillar in the centre of the flower. This order furnishes an extensive collection of herbs, both annual and perennial, shrubs,

shrubs, and trees. These are very different in size and height, from the creeping mallows, and low shrub by tea-tree, to the fleshy limes, and more lofty silk-cotton-trees, which by some modern writers are affirmed to be so large as not to be lathomed by sixteen men, and so tall that an arrow cannot reach their top. The genera are the following: Bixa, arnotta, or anotta, by the French, roucou; Corchorus, jew's mallow; Heliocarpus, tree-montia; Kiggelaria; Microcos; Muntingia; Thea, tea-tree; Tilia, lime or linden-tree; Turnera, nettle-leaved cistus; Triumphetta, burrbark-tree; Ayenia; Grewia; Helicteres, screw-tree; Kleinovia; Adansonia, Æthiopian four gourd, or African calabash-tree; Alcea, hollyhock, or rose-mallow; Althæa, marsh-mallow; Bombax, silk-cotton tree; Camellia, Japan rose; Gossypium, cotton-tree; Hermannia; Hibiscus, althæa frutex, or Syrian mallow; Lavatera, sea tree-mallow; Malope, base mallow; Malva, mallow; Melochia; Napæa; Pentapetes; Sida, Indian mallow; Stewartia; Theobroma, chocolate-nut, or base cedar of Jamaica; Urena; Waltheria.

38. TRICOCCÆ, from *τρεις*, three, and *κοκκος*, a grain; consisting of plants with a single three-cornered capsule, having three cells or internal divisions, each containing a single seed. The single seed-vessel of these plants is of a singular form, and resembles three capsules, which adhere to one common footstalk as a centre, but are divided externally into three deep partitions. The genera are, Acalypha; Adelia; Andrachne, base orpine; Buxus, box; Cambogia; Carica, papaw-tree; Cliffortia; Clutia; Cneorum, widow-wail; Croton, base ricinus; Cupania; Dalechampia; Euphorbia, burning thorny plant, or spurge; Excæcaria, aloes-wood; Guettarda; Hernandia, jack-in-a-box; Hippomane, manchineel-tree; Hura, sand-box-tree; Jatropha, cassava, or manihot; Mercurialis, mercury; Phyllanthus, sea-side laurel; Plukenetia;

kenetia; Ricinus, palmachristi; Solandra; Sterculia; Tragia; Triallis. This family is not completely natural, yet the title is a striking one; and, though the plants which possess it are not connected by such numerous relations as to form a true natural assemblage, yet they are by that circumstance distinguished from all other plants with great facility. All the genera of this order have not the striking character just mentioned.

39. *SILICOSES*, from *siliqua*, a pod, consist of plants which have a pod for their seed-vessel. This order chiefly furnishes biennial and perennial herbs of an irregular figure. The genera are these: Arabis, wall-crefs; Brassica, cabbage, turnip, rape; Bunias, sea-rocket; Cardamine, lady's smock; Cheiranthus, stock, or wall-flower; Crambe, sea-cabbage; Dentaria, tooth-wort; Erysimum, hedge-mustard; Helio-phila; Hesperis, rocket, queen's July flower, or dame's violet; Isatis, woad; Raphanus, radish; Ricotia; Sinapis, mustard; Sifymbrium, water-creffes; Turritis, tower-mustard; Alyssum, madwort; Anastatica, rose of Jericho; Biscutella, buckler-mustard; Clypeola, treacle-mustard; Cochlearia, scurvy-grafs, or spoon-wort; Draba, whitlow-grafs; Iberis, candy-tuft, or sciatica-crefs; Lepidium, dittander, or pepper-wort; Lunaria, satin-flower, honesty, or moon-wort; Myagrums, gold of pleasure; Peltaria; Subularia, rough-leaved alysson; Thlaspi, mithridate-mustard, or shepherd's purse; Vella, Spanish crefs.

40. *PERSONATE*, from *persona*, a masque, consist of plants whose flowers are furnished with an irregular gaping or grinning petal, in figure somewhat resembling the snout of an animal. This order furnishes both herbaceous and woody vegetables of the shrub and tree kind. The genera are, Collinsonia, horse-weed; Dianthera; Gratiola, hedge-hyssop; Justicia, beetle-nut; Scoparia; Verbena, vervain; Veronica, speedwell; Acanthus, bear's-breech; Antirrhinum;

hinum, calves-snout, toad's-flax, or snap-dragon; Avicennia; Barleria; Bartia; Belleria; Bignonia, trumpet-flower; Bontia, Barbadoes wild olive; Buchnera; Capraria, sweet-weed; Chelone, humming-bird tree; Citharexylum, fiddle-wood; Clerodendrum; Columnea; Cornutia; Craniolaria; Cymbaria; Dodartia; Duranta; Erinus; Euphrasia, eye-bright; Gerardia; Gesneria; Gmelina; Haileria, African fly, or honey-suckle; Lantana, American viburnum; La-hræa; Manulea; Martynia; Melampyrum, cow-wheat; Mimulus, monkey-flower; Obolaria; Orobanche, broom-rape; Ovieda; Pedicularis, rattle-coxcomb, or louse-wort; Petrea; Phryma; Rhinanthus, elephant's-head; Ruellia; Schwalbea; Scrophularia, fig-wort; Stemodia; Torenia; Tozzia; Vandellia; Vitex, agnus castus, or chaste-tree; Volkameria.

41. ASPERIFOLIÆ, rough-leaved plants, viz. Anchusa, bugloss; Asperugo, small wild bugloss, or great goose-grass; Borrigo, borragé; Cynoglossum, hound's-tongue, Venus's navel wort, or lawn; Echium, viper's bugloss; Heliotropium, turnsole; Lithospermum, gromwell, or graymill; Lycopsis; Myosotis, mouse-ear scorpion-grass; Onosma; Pulmonaria, lung-wort, or sage of Jerusalem; Symphytum, comfrey; Cerinthe, honey-wort; Nolana; Cordia, sebesten; Varonia; Tournefortia, base withe; Ehretia, base cherry-tree; and Patagonula. The greater part of these are herbaceous and perennial.

42. VERTICILLIATÆ, consist of herbaceous vegetables, having four naked seeds, and the flowers placed in whirls round the stalk. The genera are, Ajuga, bugle; Amethystea, amethyst; Ballotta, black horehound; Betonica, betony; Cleonia; Clenopodium, field basil; Cunila, Virginian penny-royal; Dracocephalum, dragon's-head; Galeopsis, hedge-nettle; Glechoma, ground-ivy; Horminum, Pyrenæan clary; Hyssopus, hyssop; Lamium, dead nettle; Lavandula, lavender; Leonurus, lion's-tail; Lycopus, water horehound;

hound; Marrubium, horehound; Melissa, balm; Melittis, base balm; Mentha, mint; Moluccella, Molucca balm; Monarda, Oswego tea; Nepeta, catmint, or nep; Ocymum, basil; Origanum, marjoram; Orvala; Phlomis, sage-tree, or Jerusalem sage; Prasium, shrubby hedge-nettle; Prunella, self-heal; Rosmarinus, rosemary; Salvia, sage; Satureia, savory; Scutellaria, scull-cap; Sideritis, iron-wort; Stachys, base horehound; Teucrium, germander; Thymbra, mountain hyssop; Thymus, thyme; Trichostema; and Ziziphora, Syrian field-basil. The plants of this order are fragrant, warm, and penetrating, and their chief virtue resides in the leaves.

43. DUMOSÆ, from *dumus*, a bush, consist of a number of shrubby plants, which are thick set with irregular branches, and bushy. The plants of this order are all of the shrub and tree kind, rising from six to forty feet high. The genera are, Achras, sapota; Cassine, cassioberry-bush, and South-Sea or Paraguay tea; Ceanothus, New-Jersey tea; Celastrus, staff-tree; Chrysophyllum, star-apple, and damson-tree; Fagara; Ilex, holly; Phyllica, base alaternus; Prinos, winter-berry; Rhamnus, buckthorn, or jujube-tree; Rhus, sumach, or poison-tree; Schinus, Indian mastic; Sideroxylon, iron-wood; Callicarpa, John-sonia; Euonymus, spindle-tree; Sambucus, elder; Tomex; Viburnum, pliant mealy-tree, or wayfaring-tree, laurustinus, and guelder-rose. The berries, bark, and flowers, of many of these plants, are purgative.

44. SEPIARIÆ, from *sepes*, a hedge, consist of a beautiful collection of woody plants, some of which, from their size, elegance, and other circumstances, are very proper to adorn shrubberies. The genera are, Chionanthus, snowdrop-tree, or fringe-tree; Fraxinus, ash-tree; Jasminum, jessamine; Ligustrum, privet; Nyctanthes, Arabian jessamine; Olea, olive; Phillyrea, mock privet; Syringa, lilac. This order furnishes woody plants both of the shrub and tree

kind, most of which do not drop their leaves till nearly the time when the new leaves begin to appear.

45. *UMBELLATÆ*, from *umbella*, an umbel, consist of plants whose flowers grow in umbels, with five petals that are often unequal, and two naked seeds that are jointed at the top, and separated below. These plants are herbaceous, and chiefly perennial. The genera are, *Ægopodium*, herb-gerard, gout-wort, or wild angelica; *Æthusa*, lesser hemlock, or fool's parsley; *Ammi*, bishop's-weed; *Anethum*, dill, or fennel; *Angelica*; *Apium*, parsley; *Arctopus*; *Arteria*; *Astrantia*, black master-wort; *Athamanta*, spignel; *Bubon*, Macedonian parsley; *Bunium*, pig-nut, or earth-nut; *Bupleurum*, hare's-ear; *Cachrys*; *Carum*, cari, or caraway; *Caucalis*, base parsley; *Chærophylum*, chervil; *Cicuta*, water-hemlock; *Conium*, hemlock; *Coriandrum*, coriander; *Crithmum*, samphire; *Cuminum*, cumin; *Daucus*, carrot; *Echinophora*, prickly parsnip; *Eryngium*, eringo; *Ferula*, fennel-giant; *Hasselquistia*; *Heracleum*, cow-parnsnip; *Hydrocotyle*, water navel-wort; *Imperatoria*, master-wort; *Laserpitium*, laserwort; *Ligusticum*, lovage; *Oenanthe*, water-dropwort; *Pastinaca*, parsnip; *Peucedanum*, hog's fennel, or sulphur-wort; *Phellandrium*; *Pimpinella*, burnet-saxifrage; *Sanicula*, sanicle; *Scandix*, shepherd's-needle, or Venus's comb; *Selinum*, milk-parsley; *Seseli*, hart-wort of Marseilles; *Sium*, water-parnsnip; *Sison*, base stone-parsley; *Smyrnum*, alexanders; *Thapsia*, deadly carrot, or scorching-fennel; *Tordylium*, hart-wort of Crete.

46. *HEDERACEÆ*, from *hedera*, ivy; consist of ivy and a few other genera that seem nearly allied to it. This order furnishes both herbaceous and shrubby plants; and its genera are, *Aralia*, berry-bearing angelica; *Cissus*, wild grape; *Hedera*, ivy; *Panax*, ginseng; *Vitis*, vine; *Zanthoxylum*, tooth-ach tree.

47. *STELLATÆ*, from *stello*, a star; consist of plants with two naked seeds, and leaves disposed round the stem

stem in form of a star. The genera are, *Anthospermum*, amber-tree; *Asperula*, woodroof; *Crucianella*, petty madder; *Diodia*; *Galium*, lady's bedstraw, or cheese-rennet; *Hedyotis*; *Knoxia*; *Lippia*; *Phyllis*, base hare's-ear; *Richardia*; *Rubia*, madder; *Sherardia*, little field-madder; *Spermacoce*, button-weed; *Varantia*, cross-wort; *Houstonia*; *Oldenlandia*; *Ophiorrhiza*, serpent's-tongue; *Spigelia*; worm-grass; *Coffea*, coffee-tree; *Cornus*, dog-wood, or cornelian cherry; *Ixora*, American jessamine; *Pavetta*; and *Psychotria*, ipecacuanha. This order contains herbs, shrubs, and trees.

48. *AGGREGATÆ*, from *aggregare*, to assemble or collect, comprehend those plants which have aggregate flowers, consisting of a number of florets or small flowers, each of which has a proper and common calyx. The genera are, *Statice*, thrift, or sea-pink; *Hartogia*; *Brunia*; *Protea*, silver-tree; *Globularia*, blue daisy; *Leucadendron*; *Hebenstretia*; *Selago*; *Cephalanthus*, button-wood; *Dipsacus*, teasel; *Scabiosa*, scabious; *Knautia*; *Allionia*; *Valeriana*, valerian; *Morina*; *Boerhavia*; *Circæa*; *Lonicera*, honeysuckle; *Chiococca*, snow berry; *Trioestum*, fever-root, or tinker's-weed; *Mitchella*; *Linnæa*; *Morinda*; *Conocarpus*, button-tree; *Loranthus*; *Viscum*, mistletoe.

49. *COMPOSITÆ*, consist of plants with compound flowers. In this order Linnæus has constructed his first or primary divisions from the different sexes of the florets, which he terms *polygamy*; the subaltern divisions are constructed from the figure of the petals, the disposition of the flowers, the pappus or crown of the seed, the common receptacle, and other circumstances which characterize the subaltern divisions in other authors. The genera are, *Gundelia*; *Echinops*, globe-thistle; *Sphæranthus*, globe-flower; *Arctium*, burdock; *Serratula*, saw-wort, or way-thistle; *Carduus*, thistle; *Onopordon*, woolly or cotton

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thistle;

thistle; Cynara, artichoke; Carlina, carline-thistle; Gorteria; Atractylis, distaff-thistle; Carthamus, base saffron; Centaurea, centaury, blue-bottle, or knapweed; Elephantopus, elephant's foot; Scolymus, golden-thistle; Cichorium, succory, or endive; Cactananche, Candia lion's-foot; Lapsana, nipple-wort; Hypochæris, gosmore; Seriola; Hyoseris, yellow-eye; Andryala, downy sow-thistle; Crepis, base hawkweed; Hieracium, hawkweed; Leontodon, dandelion; Prenanthes, wild lettuce; Chondrilla, gum succory; Lactuca, lettuce; Sonchus, sow-thistle; Picris, ox-tongue; Scorzonera, viper's grass; Tragopogon, goat's-beard; Geropogon, old man's beard; Gnaphalium, everlasting, or cudweed; Xeranthemum, Austrian sneeze-wort; Stæhelina; Tanacetum, tansy; Matricaria, feverfew; Carpesium; Chrysanthemum, corn-marygold; Pteronia; Baccharis, ploughman's spikenard; Osmites; Conyza, greater fleabane; Inula, elecampane; Erigeron, lesser fleabane; Cineraria, sky-flower; Tussilago, coltsfoot; Doronicum, leopard's-bane; Arnica; Senecio, groundsel, or ragwort; Solidago, golden-rod; Chrysocoma, goldy locks; Aster, star-wort; Leysera; Santolina, lavender-cotton; Anthemis, chamomile; Anacyclus; Cotula, may-weed; Alhanasia; Achillea, milfoil, or yarrow; Cacalia, foreign coltsfoot; Perdicium; Bellis, daisy; Ageratum, base hemp-agrimony; Eupatorium, hemp-agrimony; Ethulia; Kuhnia; dwarf American laurel; Corymbium; Helenium, base sun-flower; Othonna, African ragwort; Calendula, marygold; Arctotis; Osteospermum, hard-seeded chrysanthemum; Bidens, water hemp-agrimony; Verbesina, Indian hemp-agrimony; Sigesbeckia; Coreopsis, tickseed sun-flower; Silphium, base chrysanthemum; Tetragonotheca; Polymnia, dwarf sun-flower; Helianthus, sun-flower; Rudbeckia, Milleria; Buphthalmum, ox-eye; Chrysogonum; Melampodium; Tridax, trailing star-wort; Pectis; Tagetes, African marygold;

marygold; Zinnia; Calea, halbert-weed; Amellus, star-flower; Stoebe, base Ethiopian elychnis; Tarchoanthus, shrubby African fleabane; Artemisia, wormwood, or mugwort; Seriphium; Erioccephalus; Filago, cotton, or cudweed; Micropus, base cudweed; Iva, false Jesuits' bark tree; Parthenium, base feverfew; Ambrosia; Strumpfia; Xanthium, lesser burdock.

50. AMENTACEÆ, from *amentum*, a catkin; plants bearing catkins; as, Salix, willow; Populus, poplar; Platanus, plane-tree; Sloanea, apeiba of the Brasils; Fagus, beech-tree; Juglans, walnut-tree; Quercus, oak-tree; Corylus, hazel-nut-tree; Carpinus, hornbeam-tree; Betula, birch-tree; Myrica, candleberry-myrtle, or gale; Pistacia, pistachia nut-tree; and Cynomorium.

51. CONIFERÆ, from *conus*, a cone, and *fero*, to bear; consist of plants, whose female flowers, placed at a distance from the male, either on the same or distinct roots, are formed into a cone. In this character, the only one expressed in the title, the plants in question seem to be nearly allied to the family of mosses: from which, however, they are easily distinguished by their habit, as well as by the structure of the small flowers, in which the stamina are united below into a cylinder, and distinct at top. The plants of this order are mostly of the shrub and tree kind, and retain their leaves all the year. The form of these plants is generally conic, and extremely beautiful, from the disposition of the branches, which cover the stems even to the roots, extending themselves horizontally and circularly like so many rays. The height of some genera of this order does not exceed half a foot, that of others approaches to an hundred feet. The genera are, Cupressus, cypress; Ephedra, shrubby horse-tail; Equisetum, horse-tail; Juniperus, juniper; Pinus, fir, pine, cedar, larch; Taxus, yew-tree; Thuja, arbor vitæ.

52. COADUNATÆ,

52. *COADUNATÆ*, from *coadunare*, to join or gather together; so termed from the general appearance of the seed-vessels, which are numerous, and, being slightly attached below, form all together a single fruit in the shape of a sphere or cone; the parts of which, however, are easily separated from one another. This order, which consists of exotic plants, furnishes a beautiful and choice collection of shrubs and trees, both evergreen and deciduous. The genera are, *Annona*, the custard-apple; *Liriodendron*, the tulip-tree; *Magnolia*, laurel-leaved tulip-tree; *Michaelia*; *Uvaria*; *Xylopiæ*, bitter wood. The plants of this order have a strong, agreeable, and aromatic, smell: the fruits and seeds have a pungent taste like pepper; the bark and wood are bitter.

53. *SCABRIDÆ*, from *scaber*, rough, rugged, or bristly, consist of plants with rough leaves. There seems to be some impropriety in characterizing these plants by a name expressive of the roughness of their leaves, as that circumstance had previously furnished the classic character of the *Asperifoliæ*. The degree of roughness, however, is much greater in the plants which make the subject of the present article. The plants of this order are in general of an astringent nature; their taste is bitter and styptic. The genera are, *Acnida*, Virginian hemp; *Bosæ*, yervamora, or golden rod-tree; *Cannabis*, hemp; *Cecropia*, trumpet-tree; *Celtis*, nettle-tree; *Dorstenia*, contrayerva; *Ficus*, fig; *Humulus*, hop; *Morus*, mulberry-tree; *Parietaria*, pellitory; *Theligonum*, dog's-cabbage; *Ulmus*, elm-tree; *Urtica*, nettle.

54. *MISCELLANÆ*, miscellaneous plants. This order consists of such genera as are not connected together by very numerous relations. They are, *Datisca*, base hemp; *Reseda*, base rocket, or dyer's weed; *Poterium*, garden burnet; *Sanguisorba*, greater wild burnet; *Lemna*, duckmeat; *Pistia*, water-houseleek; *Coriaria*, myrtle-leaved sumach; *Empetrum*, black
berried

berried heath, or crow-berries; *Achyranthes*, cadelari; *Amaranthus*, amaranth, or flower-gentle; *Celosia*, cock's-comb; *Gomphrena*, globe-amaranth; *Iresine*; *Phytolacca*, American nightshade; *Nymphæa*, water-lily, *Sarracenia*, side-saddle flower; *Cedrela*, Barbadoes base cedar; *Swietenia*, mahogany; *Corrigiola*, base knot-grass; *Limeum*; *Telephium*, true orpine.

55. *FILICES*, ferns; consist of plants which bear their flower and fruit on the back of the leaf or stalk. These plants, in figure, approach the more perfect vegetables; being furnished, like them, with roots and leaves. The genera are, *Acrostichum*, forked fern; *Adiantum*, maiden-hair; *Asplenium*, spleenwort, or milt-waste; *Blechnum*; *Hemionitis*, mule's-fern; *Isoetes*, quill-wort; *Lonchitis*, rough spleenwort; *Polypodium*, polypody; *Pteris*, brakes, or female fern; *Trichomanes*, Tunbridge maiden-hair; *Marsilea*; *Onoclea*, sensible fern; *Ophioglossum*, adder's-tongue; *Osmunda*, osmund-royal, or flowering fern; *Pilularia*, pepper-grass.

56. *MUSCI*, mosses. These plants resemble the pines, firs, and other evergreens of that class, in the form and disposition of their leaves, and manner of growth of the female flowers, which are generally formed into a cone. They frequently creep, and extend themselves like a carpet upon the ground, trees, and stones, being generally collected into bunches and tufts; the smallest are only one-third of an inch in height, and the largest do not exceed five or six. The genera are these: *Bryum*; *Buxbaumia*; *Fontinalis*, water-moss; *Hypnum*; *Lycopodium*; *Mnium*; *Phascum*; *Polytrichum*, golden maiden-hair; *Porella*; *Sphagnum*; *Splachnum*. The mosses in general are almost tasteless, have few juices, and being once dried do not readily imbibe moisture from the air. Those which grow in water, being thrown into the fire, grow red, and are reduced to ashes without receiving or communicating any flame.

They

They are all of wonderful efficacy in preserving dry such bodies as are susceptible of moisture; and in retaining, for a long time, the humidity of young plants without exposing them to putrefaction.

57. *ALGÆ*. This order consists of plants whose root, leaf, and stem, are all one. Under this description are comprehended all the sea-weeds, and some other aquatic plants; as already stated, p. 219, seq.

58. *FUNGI*, mushrooms. These plants are rarely branched, sometimes creeping, but most commonly erect. Such as are furnished with branches, have them of a light spongy substance like cork. - Mushrooms differ from the fuci, in that those which, like the fuci, have their seeds contained in capsules, are not branched, as that numerous class of sea-weeds are. The greatest part of mushrooms have for a root a number of fibres, which, by their inosculation, frequently form a net with unequal meshes, some of which produce plants similar to their parent vegetable. The genera of this order are enumerated and explained in p. 241.

Under the name *Dubii Ordinis*, Linnæus classes all the other genera which cannot be reduced to any of the above-mentioned orders, and which are nearly one hundred and twenty in number, as may be seen by referring to his *Fragmenta Methodi Naturalis*.

Such are the *Fragmenta Methodi Naturalis* of Linnæus; which resulted from his endeavours to form a Natural Method of Plants; and which he recommends to the notice of those who might have sufficient resolution to follow up the same pursuit. That a system founded on the natural affinities of plants, would be a valuable acquisition to botany, is admitted on all hands; and therefore it were to be wished, that, instead of multiplying artificial systems, the learned and ingenious in chemistry and botany would unitedly endeavour to trace out nature's path in the combinations and properties of vegetable affinities, until

until this desideratum shall be obtained. That such a discovery may not be far distant, we have every reason to hope, as well from the avidity with which general learning is now pursued, as from the astonishing advances made in the sister sciences of chemistry and botany within our own day; particularly from the brilliant discoveries of the ingenious but ill-fated Lavoisier; and the rapid, though recent, introduction of the sexual hypothesis into the schools. It is no longer ago than the year 1762, that Dr. Martyn was appointed to the botanical chair at Cambridge, and first introduced the Linnæan system and language in a course of public lectures. They were at that time *both entirely new* to the university, and very little known or attended to in other parts of the kingdom; except at Edinburgh, by the laudable efforts of the late Dr. Hope.

That useful improvements, and scientific discoveries, even after they are made, can only advance to maturity by degrees, and receive their finish from the progressive labours of *the many*, is a fact which admits not of a doubt. In the retrospective view above given of the writers on botany, it is apparent that each one improved on the others' ideas; but the talent of collecting the most valuable parts of the whole, and of combining them into one rational and classical system, was left to dignify the name of Linnæus. Similar results may still arise from similar researches; and, though it is too common a maxim to think and speak contemptuously of inferior writings and suggestions on different topics, yet, as far as any one contributes his mite to the general stock, or furnishes an idea that can be improved by others, he is justly entitled to a share of the public regard. We have seen, that, even in the science of botany, a journeyman weaver could accomplish what the celebrated Mr. Philip Miller declared to be impossible; and it is obvious that the labours of the meanest individuals

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dividuals are found expedient to the comforts of elevated life, and are perhaps the source of the very bread we eat. This ought to convince us how intimately every link of the great chain of society is connected, and should fill our hearts with sentiments of regard for all our fellow men, how distant soever their avocations and stations may be; since most of the gifts of superiority seem primarily to have arisen out of the inventions or suggestions of others. How much then must the compiler of this work owe to the industry of those who have gone before him, in the arduous pursuits of natural history! nor can he compensate for the valuable matter selected from the labours of those who have had the happiness to excel, but by placing their works in the most striking and useful point of view. Doubtless the improvements in science and the liberal arts, have been in a great measure owing to the establishment of learned societies, and to the mutual communications of distant individuals; whence it should seem, that the minds of men, like the stars in heaven, were made by turns to enlighten and eclipse each other.

OF COLLECTING AND PRESERVING PLANTS.

MANY methods have been devised for the preservation of plants; we shall relate only such as have been found most successful. Dr. Withering, in his Arrangement of British Plants, recommends the following: First prepare a press, which a workman will make by the following directions. Take two planks of well-seasoned wood, not liable to warp. The planks must be two inches thick, eighteen inches long, and twelve inches broad. Get four male and four female screws; such as are used for securing sash-windows. Let the four female screws be let into the four corners of one of the planks, and corresponding holes made through the four corners of the other plank

plank for the male screws to pass through, so as to allow the two planks to be screwed tightly together. It will not be amiss to face the bearing of the male screws upon the wood with iron plates; and, if the iron plates went across from corner to corner of the wood, it would be a good security against the warping. When a press is not at hand, the specimens may be dried tolerably well between the leaves of a large folio book, laying other books upon it to give it the necessary pressure; but in all cases too much pressure must be avoided. - Secondly, get a few sheets of strong card pasteboard, and half a dozen quires of large, soft, spongy, paper; such as the stationers call blossom or blotting paper, is the best.

The plants you wish to preserve should be gathered in a dry day, after the sun has exhaled the dew: taking particular care to collect them in that state wherein their general and specific characters are most conspicuous. Carry them home in a tin box, which may be made about nine inches long, four inches and a half wide, and one inch and a half deep. Get the box made of the thinnest tinned iron that can be procured; and let the lid open upon hinges. The box should be painted, or lacquered, to prevent rusting. If any thing happens to hinder the immediate use of the specimens you have collected, they will be kept fresh two or three days in this box, much better than by putting them in water; but the blossoms of some plants are so very delicate, that they shrivel in a very short time, and often before you can well examine them. In this case, put the stems in water, cover the whole with a glass bell, like those used in gardens, or the receiver of an air-pump; expose them to the sun and, in half an hour, you will find them completely expanded. When you are about to preserve them, lay them down upon a pasteboard, as much as possible in their natural form; but at the same time with a particular view to their generic and specific characters.

characters. For this purpose it will be adviseable to separate one or more of the flowers, and to display them so as to show the generic character. If the specific character depends upon the flower, or upon the root, a particular display of that will be likewise necessary. When the plant is thus disposed upon the pasteboard, cover it with eight or ten layers of the blotting-paper, and put it into the press. Exert only a small degree of pressure for the first two or three days; then examine it, unfold any wrinkles or plaits, rectify any mistakes, and, after putting fresh paper over it, screw the press a little harder. In about three days more, separate the plant from the pasteboard, if it be sufficiently firm to allow of a change of place; put it upon a dry fresh pasteboard, and covering it with fresh blossom-paper, let it remain in the press a few days longer. The press should stand in the sun-shine, or within the influence of a fire, for nothing is so destructive to the beauty of the specimens as long-continued dampness. Shrubs and many of the harder perennial plants will lie much neater in the herbarium, if the bark of the principal stem be slit up with the point of a sharp knife, so as to allow the inner woody part to be extracted.

When it is perfectly dry, the usual method is to fasten it down with paste, or gum-water, on the right-hand inner page of a sheet of large strong writing-paper. It requires some care to fix the plant neatly down, so that none of the gum or paste may appear to defile the paper. Press it gently again for a day or two, with a half-sheet of blossom-paper between the folds of the writing-paper. When it is quite dry, write upon the left-hand inner page of the paper, the name of the plant; the specific character; the place where, and the time when, it was found; and any other remarks you think proper. Upon the back of the same page, near the fold of the paper, write the name of the plant, and then place it in your cabinet.

A small

A small quantity of finely-powdered arsenic, or corrosive sublimate, is frequently mixed with the paste or gum-water, to prevent the devastations of insects; but the seeds of flaves-acre, finely powdered, will answer the same purpose, without being liable to corrode or to change the colour of the more delicate plants. A little alum added to the paste makes it keep longer, and a little coarse brown sugar dissolved in the gum-water renders it less brittle when dry. Some people put the dried plants into the sheets of writing-paper, without fastening them down at all, which is far the most useful way: others only fasten them by means of small slips of paper, pasted across the stem or branches, and others again sew them to the paper with fine thread or silk.

Another more expeditious method is to take the plants out the press, after the first or second day; let them remain upon the pasteboard; cover them with five or six leaves of blossom-paper, and iron them with a hot smoothing iron, until they are perfectly dry. Care must be taken that the iron be not made too hot, or it will change the colours. This is the best method to treat the different species of Orchis, and other slimy mucilaginous plants.

The following method of preserving plants in their original shape and colour, is recommended in the *Encyclopædia Britannica*. Wash a sufficient quantity of fine sand so as perfectly to separate it from all other substances; dry it; pass it through a sieve to clear it from any gross particles which would not rise in the washing: take an earthen vessel of a proper size and form, for every plant and flower which you intend to preserve; gather your plants and flowers when they are in a state of perfection, and in dry weather, and always with a convenient portion of the stalk; heat a little of the dry sand prepared as above, and lay it in the bottom of the vessel, so as equally to cover it; put the plant or flower upon it, so as that

no part of it may touch the sides of the vessels; sift or shake in more of the same sand gradually upon it, so that the leaves may be extended by degrees, and without injury, till the plant or flower is covered about two inches thick: put the vessel into a stove, or hot-house, heated by little and little to the 50th degree; let it stand there a day or two, or perhaps more, according to the thickness and succulence of the flower or plant; then gently shake the sand out upon a sheet of paper, and take out the plant, which you will find in all its beauty, the shape as elegant, and the colour as vivid, as when it grew. Some flowers require certain little operations to preserve the adherence of their petals, particularly the tulip; with respect to which it is necessary, before it is buried in the sand, to cut the triangular fruit which rises in the middle of the flower, for the petals will then remain more firmly attached to the stalk.

The following improved method of preserving plants, is the invention of T. Velley, esq. of Bath, author of *Observations on the Propagation of Marine Plants, &c.* Place the plant, when fresh, between several sheets of blotting-paper, and iron it with a large smooth heater, pretily strongly warmed, till all the moisture is dissipated. Fix down the flowers and fructification with gum, upon the paper on which they are to remain, and iron them in that state, by which means they become almost incorporated into the paper in their proper forms. Many colours have been fixed by this means, which frequently forsook the flowers during the gradual and tedious process of sand-heats, and other methods of a similar nature. Some plants require a more moderate heat than others: experience must determine this; and herein consists the nicety of the experiment. Major Velley says, "The forms and colours seem to remain more perfect by this mode than by any other I have been able to try. If the mucilaginous and succulent plants do

do not succeed so well with respect to their colour, under the hot smoothing-iron, I have always found that they failed full as much, or more, when preserved by other means. The colours of the blossoms in the class didynamia I could never fix by a sand-heat; yet several of these, as well as of the rough-leaved plants, I have preserved tolerably well by ironing."

It is necessary to observe, that in compound flowers, or in those of a solid and more stubborn form, as the *Centaurea*, &c. some little art must be employed in cutting away the under part, by which means the profile and form of the flowers will be more distinctly exhibited, provided they are to be re-pasted down. After all, it must be remembered that a plant, when preserved in a most perfect state, is a kind of hygrometer; and if exposed for any time to a moist atmosphere, or laid up in a situation which is not perfectly dry, will imbibe a degree of humidity that must soon prove injurious to the beauty of the specimen.

The following method of preparing plants for an herbarium, is given by Mr. Whateley, surgeon, in London.—Previous to the drying of plants by this plan, it will be necessary to procure the following apparatus. 1. A strong oak box of the size and shape of those used for the packing up of tin plates. 2. A quantity of fine dry and searced sand of any kind, sufficient to fill the box. 3. A considerable number of pieces of pliant paper, from one to four inches square. 4. Some small flat leaden weights, and a few small bound books.

The specimen of any plant intended for the herbarium, should be carefully collected when dry and in the height of its flowering, with the different parts as perfect as possible, and in the smaller plants the roots should be taken up. It should then be brought home in a tin box well closed from the air. The plants should be cleared from the decayed leaves and dirt,
and

and afterwards laid upon the inside of one of the leaves of a sheet of common cap-paper. The upper leaves and flowers should then be covered in an expanded state by pieces of the prepared paper, which may be placed in any irregular way, and kept down by the fingers till these parts of the plant are entirely covered by them; and after that let one or two of the leaden weights be placed upon the papers. As the beauty of the specimen depends very much upon this part of the process, each large petal ought to be laid flat separately with a piece of paper, and the utmost care taken that every part of the plant be laid down without folds, which may be done in general in a short time. The parts of the plant below should then be covered with the pieces of paper, and likewise with the weights, and thus the whole plant should be laid in its proper expanded form by the same method. The weights should then be carefully removed, and the other leaf of the sheet of paper applied to its opposite one, having the loose pieces of paper and plant between them. After which, one or two of the books should be placed on the outside of the paper, and remain there till as many other plants as are intended to be preserved have been prepared in like manner. A layer of sand an inch deep should then be put into the box, and afterwards one of the plants with the books placed upon it, which last should be removed after a sufficient quantity of sand is put upon the paper, to prevent the plant from varying its form. All the other plants may then be put into the box in the same manner, with a layer of sand about an inch thick between each, when the sand should be gently pressed down by the foot, and the degree of pressure in some measure regulated by the kind of plants in the box. If they are stiff and firm, as the holly or furze, much pressure is required. If tender and succulent, a less degree is better, for fear of extravasating the juices, which would injure the colour

colour of the plant; but particular care should be taken to make a sufficient degree of pressure upon the expanded blossoms of plants, that they may not shrivel in drying. The box should then be carefully placed before a fire, with one side a little raised, or occasionally flat, as may be most convenient, alternately changing the sides of the box to the fire, twice or thrice a-day; or, when convenient, it may be put into an oven in a gentle heat. In two or three days the plants will be perfectly dry. The sand should then be taken out with a common plate, and put into a spare box, and the plants carefully taken out also, and removed to a sheet of writing-paper.

This method of preserving plants is from much experience found to possess every advantage that can be wished for; it dries most of them of an exceeding fine natural and durable colour, as well in the flowers as leaves. It will be found upon trial, that a different degree of heat is suitable to different plants, (the exact knowledge of which will be easily acquired by a little experience,) and that some will dry much better than others. Those plants that have coloured flowers should be placed uppermost, otherwise their colour will be injured by the slow dissipation of the moisture from the others. Plants are most fit for future examination when preserved loose within the paper; and if they are kept in a very dry room, and unexposed to the air, they will preserve their beauty a great number of years; but it will be necessary to inspect them once a-year, to destroy any of the small insects that may breed among them; and this will be fully sufficient for their preservation. In whatever method the plants are dried, these precautions are indispensable to their preservation. They may be most conveniently kept in a cabinet made for the purpose, with the drawers open in front, excepting only a shallow ledge at the bottom of each; placing the species of each genus together, and keeping each class separate.

In the class Cryptogamia, a different management may be adopted with advantage, except in the Filices, or ferns, and these may be dried and disposed of the same as the plants of the other classes; but the Musci, or mosses, which constitute the second order of the Cryptogamia class, being very numerous, and mostly very minute, may be kept in papers folded to the octavo size. It is sufficient to place them in the papers, and to give them a moderate pressure for a short time. They dry readily, and are not apt to spoil.

The preservation of the Algæ, or third order of this class, requires some farther directions. The Lichens require no care in drying; they should not even be pressed nor put into papers, but placed in shallow close drawers which are divided into small partitions. The Conservæ, and the finer-leaved Fuci, cannot be advantageously laid down in the common way, but should be floated in a large shallow dish of water, so as to separate and expand their delicate branches. A stiff piece of writing-paper may then be made to slide under them; and with a little address the paper may be drawn out of the water so as to bring out the plant upon it, in its beautiful and expanded state. If the whole be then dried between blotting papers, under a gentle pressure, the plants will in general adhere to the writing-paper so as to preserve their form. The sea-weeds must all be soaked in large quantities of fresh water, so as to extract the salt before they are laid down to dry. If the collector has not time to examine and lay them down while at the sea-side, nothing more should be done to them, than allowing them to dry moderately in the open air, and tying them up loosely in strong brown paper. They may thus be carried without injury to any distance; and, when macerated in fresh water, will expand as fully as before, so as to admit of their being examined and preserved at leisure.

The Fungi, or fungusses, are best preserved in a pickle;

pickle; for which Dr. Withering gives the following directions: Take two ounces of vitriol of copper reduced to powder; pour upon it about a tea-cup of cold water; stir it with a piece of stick, or quill, for about a minute, then pour off the water and throw it away. On the remaining vitriol pour a pint of boiling water; and, when the whole is dissolved and grown cool, add to it half a pint of rectified spirit of wine. Filter it through paper; keep it in a bottle closely corked, and call it *the pickle*. To eight pints of pure spring-water, add a pint of rectified spirit of wine; keep this in corked bottles, and call it the *stronger liquor*. To eight pints more water, add one pint of spirit of wine, and call it the *weaker liquor*. Be provided with a number of wide-mouthed glass jars, of various sizes, capable of holding from two ounces to two pints; all very well fitted with corks.

Whatever fungus, whether agaric, or boletus, &c. you wish to preserve, should be suffered to lie upon your table as long as it can be trusted without danger of its decaying, so as to allow some part of its moisture to evaporate; the thick and fleshy plants should lie the longest, but the deliquescent ones, and those which are very thin and delicate, should be put into pickle almost immediately after they are gathered. Pour some of the pickle into a spare jar, and into this immerge the specimens to be preserved. The specimens should remain in the pickle from three hours to three days, according to their bulk and fleshiness. Then remove each specimen into the jar in which it is to be kept, suiting the size of the jar to the size of the specimens. If they are of the large, juicy, and fleshy kind, fill up the jar with the stronger liquor, but the weaker will suffice for the smaller and thinner plants. Whichever liquor be used, the jar must be quite filled with it, and immediately corked very tight. Cover the cork and the top of the jar with Venice turpentine, by means of a painter's brush. In three or four

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days

days the turpentine will become nearly dry, and then tie a piece of wetted bladder very tight over the top of the jar. These precautions are necessary to prevent the access of the air, and the evaporation of the liquor: because, if either of these happen, the specimens will soon be spoiled. The boleti are in general more difficultly preserved than the agarics, and such of either as abound with a milky juice are apt to foul the liquor, which must then be changed. Mosses and lichens may be preserved in great perfection, by this method of pickling.

To a superficial and thoughtless mind, the study of botany and the investigation of plants may appear a light and frivolous employment. But, if we reflect on the great benefits derived from a due knowledge of the cultivation and properties of the herbs and plants, as well on the score of supplying food for men and cattle, as for the extensive purposes of medicine, we shall find few pursuits more pregnant with intellectual improvement, or more conducive to the public good. The Saviour of Mankind descended to the lifeless emblems of seed sown, of the fig-tree, and of a single grain of mustard-seed, to enlighten our understandings; and if we wish to improve by the parable, and accompany nature in this solitary yet pleasing walk, we shall find in it an innocent and healthful amusement, leading us up to a devout reflection on the bounty and wisdom of him who gave us being!

OF MINERALS.

THE state of mineralogical knowledge among the ancients is unavoidably involved in much difficulty and obscurity. The writings of some of the more early naturalists have perished; those of others have been handed down to us in mutilated and imperfect forms; the restraints on scientific communication, previously to the invention of printing, were great and numerous; the principles of chemistry, which throw so much light on the composition of various masses of our globe, were long unknown; and the want of a precise nomenclature can never be supplied.

Yet the subject admits of partial explanations and probable conjectures, and is calculated to rouse the united exertions of the classical scholar and of the naturalist. We find, accordingly, that, in the elucidation of particular words and passages, critics and commentators have laboured with various success: but few have attempted to interpret the whole vocabulary of ancient mineralogy. Memoirs on the Greek and Latin designations of certain fossil substances may be found in the Transactions of various learned Societies. Millin has ably illustrated the lithology of Homer; and the Chevalier de Born collected materials for his intended *Mineralogia Veterum*, but lived not to execute his plan.

Gmelin has unduly depreciated, and Buffon as unduly over-rated, the mineralogical knowledge of the ancients. "The ancients," says Buffon, "directed all their scientific views to the objects of utility, and indulged much less than we do in idle curiosity. Whatever bore no direct relation to the interests of society, to health, to the fine arts, in short, to some useful purpose, they treated with neglect, as unworthy of occupying the human mind. Thus they regarded a stone which could be turned to no beneficial account

as wholly useless; and, so far from describing it, they did not even honour it with a name. Aristotle expressly says, there are many stones destitute of names." With all due deference to Buffon, we demur to the general position that views of direct utility alone guided the inquiries of the learned in former times. Granting, however, that the fact were established beyond dispute, the doctrine is too narrow for the approbation of an enlightened age. Curiosity naturally prompts us to examine even those objects, of which the utility is by no means apparent; and curiosity was not bestowed on us in vain. It not unfrequently conducts us to the knowledge of new and unsuspected relations, and to a rich and plentiful harvest, where the soil promised only cold and sterility.

With more propriety might M. de Buffon have noticed the astonishing powers evinced by the ancients, in drawing large masses from the bowels of the earth; and the labour which they must have exerted in the extraction of metals and precious stones; deprived as they were of the mariner's compass and gunpowder, and of many mechanical contrivances which now facilitate and multiply the operations of human industry. Without dwelling on the marbles and porphyries employed in the structure of so many magnificent edifices which have adorned Greece and ancient Rome, let us hear what Pliny says of those enormous mineral excavations which were formed in his day: "We hew down mountains, and we drag them from their base, in quest of objects which may gratify our luxury. We remove the barriers which nature seemed to have placed between nations, and we construct vessels exclusively adapted to the transportation of marble." With poignant raillery, Petronius has remarked that the Romans, after having exhausted mountains to procure different kinds of stones, have, for the same purpose, penetrated to such depths, that the shades may again hope to see the light of day.

Numbers

Numbers appear to have compensated the want of skill and ingenuity. The slave, the prisoner of war, the criminal, and even the unfortunate innocent, were condemned to drudge under the inspection of rigid taskmasters. Athenæus relates of the miners in Attica, that they once rose in rebellion, and made themselves masters of the promontory of Sunium, from which they issued into the country in predatory bands. We learn from Polybius, that forty thousand workmen were employed in the mines near Carthage; and Pliny informs us that the Vergellensian miners were limited by a special law to five thousand.

As a specimen of the obscurity attached of old to the subject of mineralogy, we may just observe, that the ancient naturalists considered rock-crystal as water in a high state of congelation; and consequently, as most abounding in very *cold* countries. Diodorus Siculus, however, ascribes its hardness to the powerful influence of the *sun's rays*; while Pliny, with becoming modesty, avows his ignorance of the cause of its hexangular formation.—Let us therefore turn at once, profitably, to the moderns.

That all matter (says sir Charles Linnæus) was primordially in a state of fluidity, and that the earth arose from the bosom of the waters, we have the testimony of Moses, Thales, and Seneca. And it is manifest, that the sea, enveloping the chaotic nucleus, produced by slow and gradual means the continent, which, by continually exhaling its dews into clouds, is regularly moistened by ethereal, rectified, deciduous, showers. Genuine remains of the general deluge, as far as I have investigated, I have not found; much less the adamitic earth: but I have every where seen earths formed by the dereliction or deposition of waters, and in these the remains of a long and gradual lapse of ages.

The WATER of the ocean, frigid, passive, concipient, every where fecundated by a dry, calescent, active, generating,

generating, air, is observed teeming with a double offspring; a *saline* male, soluble, acrid, clear, crystalline; a *terrene* female, fixed viscid, opaque, attractorial. This water, moreover, affords nourishment to two other of its offspring, Animals and Vegetables, continued in their kind by a regular catenation of seeds; and these both are reduced into earth by a perennial circle of action.

SALTS are sapid, many-sided, diaphanous, soluble into infinite minute particles always retaining their original form, and concreting again and again into larger masses of like uniform shape. These, by crystallization in and from various earths, generate various stones. *Nitre*, which is ærial, and which by obduction augments sand. *Muria*, which is marine, and which by corrosion attracts clay. *Natrum*, which is animal, and which by resudation coagulates calx. *Alum*, which is vegetable, and which by ramification cements soil. These are the *fathers of stones*.

EARTHS are reducible to dust, easily become dry, dissoluble, fixed, primitive; are generated by crystallization or formed by precipitation, produced by ascension or re-produced by putrescence. From these, by crystallization or attraction, stones are re-produced, which by the variation of the elements are repeatedly resolved into earths, and again regenerated by a like perennial circle.

Clay, the precipitation of viscid sea-water, is opaque, plastic, friable, hardening in the air, and not fusible by the action of fire.

Sand, the crystallization of turbid rain water, is hyaline, without moisture, scintillant, of the same permanent hardness, and fusible into glass.

Soil, the resolution of ascendent vegetables, is black, bibulous, reducible to dust, inflammable, and combustible.

Calx, the resolution of putrescent animals, is whitish, absorbent, farinaceous when dry, penetrable, and effervescent with acids.

CLAY,

CLAY, the earth of marine water, formerly opposed to *muria*, fordid, viscid, slippery to the touch, impalpable, without regular shape, tough, opaque, and becoming plastic by the addition of moisture; in its native situation moist, becoming friable when dry, hardening by ignition, not fusible by the greatest degree of heat, but when mixed with other heterogeneous substances becoming variously shaped by fire; after remaining a long time dry, and compressed, is hardened into *rasile Talc*, which by resolution is often regenerated into fibrous *Asbestos*, but when minutely resolved, is in a wonderful manner reproduced into scaly *Mica*.

SAND, the earth of rain-water, impregnated with ethereal nitre, shining, fixed, rigid, rough, crystalline, hyaline, not softening in water, striking fire with steel, of permanent hardness in ignition, but fusible into glass by the greatest degree of heat; cast upon the continent and dried it forms the *Aranea mobilis*, which worn by age and become friable is the *Aranea glare*; each becoming moist under ground, obliquely and transversely cleft, and ultimately uniting and forming *Sand-stone* by minute atoms of crystallizations, or mixed with humid extraneous substances is cemented into *Gravel*, and this again into various stones, stones into rocks, but when resolved and re-crystallized it forms *Quartz*.

SOIL, the earth of vegetables, eagerly combining with nitre, acescent, of a black colour, greedily imbibing moisture, crumbling into powder in fracture, reducible to dust when dry, flaming in ignition, combustible in a greater degree of heat, by continued compression is indurated into fissile *Schist*, which when saturated with bitumen becomes *Coal*. *Schist* is however often resolved into earthy *Ochre*, which by multiplied mineralization is regenerated into *Toph*.

CALX, the earth of animals, combined with *Natrum*, alkaline, of a whitish colour, absorbing acids, easily scraped with a knife, farinaceous when dry, penetrable

ble by fire, effervescing when burnt, calcifying moist and argillaceous extraneous substances into *Marble*; but when resolved and saturated with acid is re-crystallized into *Gypsum*, not again effervescing with acid without depuration by fire; and each is resolved by the elements into farinous *Chalk*, concreting by ethereal water into *Flint*, but when resolved is re-crystallized into *Spar*.

These are the *mothers of stones*.

STONES grow from earths, are again resolved, and again reproduced.

Clay is attracted into *Talc*, resolved into *Lithomarg*, and regenerated into *Amiant*.

Sand accretes together into *Free-stone*, is resolved into *Gravel*, and regenerated into *Rock*.

Soil is cemented into *Schist*, resolved into *Ochre*, and regenerated into *Toph*.

Calx is coagulated into *Marble*, resolved into *Chalk*, and regenerated into *Alabaſter*.

Diaphanous stones have their origin from a fluid mother, opaque stones from a fixed one. They are often tinged with a vitriolic alumen, varying in colour according to their various tinctures, and by these are filled and consolidated with a cicatrix the fissures of rocks.

Mica, the concretion of clay, is scaly, flexile, opaque, shining, becoming more rigid in ignition, and at the same time more shining.

Quartz, the crystallization of elementary water, is pellucid, hard, from the watery cavities of rocks, and therefore always parasitic, its crystals being often obscured by abrasion or by its bulk.

Spar, the crystallization of calcareous water, is diaphanous, fragile, whose internal rhombs an adept will easily distinguish from a different crystal; adulterated with iron it becomes harder and strikes fire with steel.

CRYSTALS are stony, produced in and from water impregnated but not saturated with salt, which abounds with

with impalpable terrestrial atoms, and is retained in the cavities of stones. They increase by long and undisturbed habitation, and are not again soluble by water into impalpable atoms. In their many-sided figure they differ from all other stones, nor have they any other, however common to most salts, which is the sole cause of crystallization at present known, nor would salts have a determinate figure unless by similar incorporation. Stalactite accretes with a crystalline covering, in like manner as calculus; and no one will venture to suppose that crystals can exist without salt, or deny that the earth is crystallized by salts. Their transparency is derived from their atomical construction, and their colour from metals. The value of gems is according to their transparency, hardness, permanency, and colour; and, from their being the principal instruments of human luxury, are often imitated by the frauds of trade.

VITRIOL, the product of alum, intimately allied to metal, is of different appearance and figure according to the nature of the metal, of which the most frequent are Iron, Copper, and Zinc; some therefore most commonly become sulphureous Pyrites, others terrene Ochres. Different Pyrites assume different figures, whose earth into which it is resolved is usually denominated Ochre, which when proceeding from Iron is yellow, and becomes red when burnt; when from Copper by acid is green, by alkali blue: so that stones which are yellow or red, are principally from Iron; those which are green or blue, from Copper. Each kind of Ochre by crystallization, coagulates earth into *Tophs*.

METALS are supra-decompound, and consist of Earth, Salt, and Sulphur. Iron, whenever present, is often dissolved by the elements; and when dissolved by vitriolic salt and an ocraceous earth precipitated, Iron by crystallization cements earths into stones, and absorbed is multiplied by metal, and so produces many

times more than it had primarily received. Vitriol stagnating in the fissures of rocks retaining water, when multiplied and precipitated by a long lapse of time, passes into a vein, which when opened transversely and filled up with a different earth, will forthwith change the metallic vein into a different one; as from Iron or Copper, Lead often becomes enriched with Silver, &c. For the same vein, by variable modification, may abound in Alum, Vitriol, Arsenic, Sulphur, Iron, Copper, Gold, Silver, Antimony, Lead, Zinc, or Bismuth.

Rocks, appearing like the prominent bones of the earth, are of great bulk, solidity, and longevity; composed of sand, gravel, opaque and diaphanous stones, with every where argillaceous, and often talcose, substances intermixed; and are at length cemented into more solid masses, with a various and irregular mixture of crystals of Quartz, Mica, and Spar. That these are the offspring of time and the strata of nature, no one will doubt, whose constituent parts are to every one palpable. In these the metallurgist will discover the matrices of minerals, many-shaped from their mixture, and diversified in fire.

PETRIFICATIONS are rather the parents than the product of marmoreous mountains, and may consist of as many diversifications as there are species of animals and vegetables. The intelligent investigator will not therefore straiten the limits of an useful science, by disregarding the ancient inhabitants of the globe, though unknown to modern naturalists. The modes of petrification are principally fourfold; Fossils, substances restored, substances impressed, and substances transubstantiated; and are more frequent in Marble, Flint, Schist, Sand-stone, Rock, and Quartz.

The difficulties of science have moreover produced various paradoxes. Consolidated fissures of rock are often distinctly visible; but by what means or power they have been broken, is not easily demonstrated.

All

All Spar is generated by crystallization, in cavities filled up, nor is spate ever present without rhombs; but how it is broken into rhombs, or how from a cubico-muriatic is produced a rhombic figure, is not very evident. Amiant is observed to be regenerated from the earth of Talc, the cause of which is obscure. That Molybdænum is metallic cannot be doubted, and it has often been asserted to be impregnated with Zinc or Tin; yet it is not easy of proof. Jews-stones are found petrified in hollow cavities, generated from a fluid with spar, of which they often entirely consist: but from what animal they have their origin is not sufficiently evident, since the echini do not afford a satisfactory elucidation.

Primary Salts have a peculiar and determinate figure; but, when changed, often appear with a different, but alike determinate, figure; but from what mixture proper to themselves, or from what extraneous terrene mixture, the student in this department has not been able to determine; and since metals are generated from salt by crystallization, alchemists have in vain laboured at the true transformation of metals; and this metamorphosis of salts must remain undiscovered, so long as metallurgists shall neglect it, and turn their investigations towards earths only.

Similar strata of the earth are often observable in broken mountains; but it is not evident that they are all of the same genus, or produced from the waters of the ocean. The lowermost stratum of *Sand-stone*. The second of *Schist*. The third of *Marble*, with marine petrifications imbedded, and often extraneous matter. The fourth of *Schist*. The fifth and uppermost of *Rock*, often of vast bulk:

It is palpable to common observation, that the ocean is the mother of the earth. The waters of ocean, made turbid by nitrous showers, are precipitated and crystallized into sand which covers the bottom of the sea. The ocean is here and there
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in vast patches, overspread with the *Fucus* natans, causing tranquillity on its surface, unless when agitated by variable winds. The soil from decayed *Fuci* gradually descends, being lighter than sand, while this marine vegetable gradually dilates itself into a floating meadow. Marine worms, molluscæ, Testaceous animals, lithophytes and zoophytes, fishes with their floating eggs, and sea-birds whose formation renders them unfit for flight, feed under this marine meadow of *Fucus*. Under the waters in a state of tranquillity, is showered down an argillaceous sediment with the calcareous shells of gradually-corrupting worms, till an elevated accumulation is formed parallel with the surface of the sea, while its pressure, moving the waters, repels the marine substances around it. For the formation of Rock, according to its own laws, the sea first casts up vast masses of *Fuci*, which moulder into soil, clothing the naked earth at the bottom with an arenaceous covering, at first easily blown about when dry, and when mixed concreting into gravel and ultimately into rocks.

By a long succession of ages therefore, and by a perennial quiescence of seasons, *Sand* is concreted into *Sand-stone*, variously but properly cleft. *Soil* is cemented into *Schist*, lamellous and combustible. *Clay* is indurated into *Marble*, conglutated by worms. *Soil* is cemented into an upper stratum of *Schist*, lamellous and combustible like the former. *Sand* is concreted into Gravel, with a mixture of other substances. This again is concreted into smaller stones, these into larger, and these last into rocks; till at length, the waters of the sea gradually subsiding, there appears a mountain: nor can the highest rocks float upon an argillaceous surface, while, before it became calcified, marine worms continue their growth in it. That the highest rocks therefore are the genuine offspring of time, while all was silence, themselves sufficiently declare. Such are the mutations produced by the lapse of time. It

It is very rarely, and indeed scarcely ever, that the *Species* can be sufficiently determined; since in these the generation proceeds not from the egg; but the multiplied variety of irregularly-sportive nature, is at once the calamity of the science and the foundation of metallurgy. He therefore that shall rashly endeavour to multiply the species, is not less absurd than him who combines substances totally different in nature. Nor does their matrix distinguish the different species, more than their natural situation and soil do the plants of the earth. The numerous diversities of stones, therefore, are principally varieties; in the arrangement of which, without caution, it is easily to fall into error.

The student has three modes of investigating this Kingdom: *Physical*, which descends through the obscure generation of minerals: *Natural*, which considers their superficial and visible structure: *Chemical*, which ascends through their destructive analysis. In this then, as in every thing else, he will most safely follow the middle course; and, by closely following his ariadnean thread, he will not, like an empyric, confound the symptoms with the cure, nor bring forward the doubtful progeny of a long-lost ancestry; much less will his terrified imagination raise up fanciful spectres in the dark, or persuade him that the Phoenix of the poets may be regenerated from its own ashes: but he will learn, what names are repugnant to things, and what are convenient; and how to define characters by their diagnostics, and not merely by their etymology.

Thus in looking at even a small collection of minerals, with a view to the description of them, it is obvious that the varieties in any one of their external characters are very numerous: various shades of colour for instance, and various modifications of form, are continually presenting themselves; and consequently the variety in the descriptive language, where accuracy is aimed at, must be proportionately great:
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and it is on this account that, in mineralogical treatises, we meet with these numerous combinations of descriptive epithets which are suggested by the endless variety of colour, texture, consistence, and in short of every separate character of a mineral. On many occasions these discriminations have been carried to a tedious and nearly useless length; and principally in the description of colour, which, of all the characters of a mineral, is perhaps the least important; a difference in this respect often depending on causes too trifling to interfere with the real nature of the substances in which it occurs. Thus in the sapphire and the ruby the colour is widely different, though the chemical analysis is nearly the same.

The characters which it is most important to ascertain in the examination of minerals are, their degrees of fusibility, their hardness, phosphorescence, electricity, their refractive power with respect to the rays of light, their specific gravity, and their crystalline form; to which should be added, as often as possible, the results of their chemical analysis.

The most ready way of ascertaining the *fusibility* of a mineral substance is, by exposing a small particle of it to the flame of a candle or lamp concentrated by the instrument called a blowpipe: and, if the heat thus excited is sufficient to liquefy the mineral, it is said to be fused. It must be observed, however, that the effect of fusion does not entirely depend, in all instances, on simple heat: for many earthy substances resist a very considerable degree of heat if placed in contact with charcoal, or a metallic substance; which, if exposed to the same heat in contact with other earthy substances, would be melted, the earths being disposed to vitrify when in contact with each other, at a much lower degree of heat than is requisite to fuse them separately. If a mineral is capable of resisting a great degree of heat without fusion, it is said to be *refractory*.

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The *hardness* of minerals has been expressed either by a comparison with each other, or their power of scratching glass; or by the effect of the file upon them: those which resist the file being the hardest.

By the *phosphorescence* of minerals is implied that faint light which they emit, either by exposure to simple heat, or in consequence of friction.

The *electricity* of a mineral is that property which being excited, either by simple heat or by friction, shows itself in the attraction or repulsion of other substances, with which the mineral is brought nearly into contact. It has been observed that some minerals acquire that kind of electricity which is called *vitreous*, as being peculiar to glass and other polished earthy substances: this is also called their positive electricity. Others acquire that kind which is called *resinous*, as being peculiar to resin and other inflammable substances: this is also called their negative electricity. Those which are in a metallic or nearly a metallic state acquire neither the vitreous, nor the resinous electricity; but altogether transmit the electric fluid. Some minerals are capable of acquiring both kinds of electricity; these are generally crystallized: and it is observed of them, that the parts which exhibit the different states of electricity differ from each other with respect to their form, although they are similarly situated; while in those crystals that are not electric the similarly-situated parts correspond also in form. If a crystal for instance consists of a prism terminated at each extremity by a pyramid, and these pyramids differ as to the kind of electricity they are capable of acquiring; it will be found that they also differ in their form; one consisting of a greater number of surfaces than the other: and the part which has the greater number of faces acquires the vitreous, the other the resinous, electricity.

It is very generally known that a ray of light in passing from one medium into another, as from air into

water, or glass, or any transparent substance, is turned more or less out of its original direction; and this alteration of course is called the *refraction* of the ray. Some transparent substances seem to have the power of also splitting the rays of light: this alteration of the course of the rays is called their double refraction; and minerals possessing this power have the property of presenting a double image of an object viewed through them.

By the *specific gravity* of a mineral is understood the amount of its weight when compared with the weight of a quantity of water of the same bulk with itself. Thus, if a cubic inch of limestone were found to be double the weight of a cubic inch of water, the limestone would be specifically heavier than the water in the proportion of two to one; and its specific gravity would be set down thus, 2. If its weight were found to be equal to the weight of two cubical inches and a half of water, it will be specifically heavier than the water, in the proportion of two and a half to one: and its specific gravity would be set down thus 2.5; the fractional parts being expressed by decimals.

The *crystalline forms* under which individual minerals occur are various, and may be considered as one of their most important characters. Every mineral substance, perhaps, if placed under particular circumstances is capable, by a peculiar arrangement of its particles, of assuming a regular and appropriate form; and as this effect was first observed in the substance known by the name of *rock crystal*, the term *crystal* was extended to every other substance possessing an analogous regularity in its form; even though it wanted that icy appearance and transparency which belong to the rock crystal, and which give rise to the term itself.

If minerals could always be made to crystallize under precisely the same circumstances, there is good ground for supposing that those of the same nature would

would always assume the same form; for it is possible in a great many instances, by carefully placing different solutions of the same substance in as similar circumstances as possible, to obtain from all proportionally similar crystals; and, as the same similarity continues in repeating the process whatever number of times, it is clear that there is in those substances a disposition to assume one particular form in preference to all others. But, as the least variation in the circumstances will produce a corresponding variation in the form, it is also clear that the variation in the form of crystals may be infinite. Hence there must necessarily be a difficulty, where the same substance presents itself under a great variety of forms, of determining the particular form which the substance would assume when placed under the most favourable circumstances for arranging its particles according to the laws of its nature:

This form, however, may generally be discovered by mechanical division; and in many crystallized substances the eye is capable of perceiving that a division may be effected in some directions much more easily than in others. Supposing therefore you were to take any one of the varieties of a crystallized substance, and, forcing the edge of a knife in those directions where there was least resistance, were to continue to make fresh and parallel sections, a solid figure would at last be extracted of a different shape from the original or any of the intermediate forms; and this figure would remain unaltered, except with respect to its size, though the division were carried to the furthest point. In cutting off, for instance, the solid angles of a cubic crystal of fluor spar, you first obtain eight new triangular surfaces: and, if you continue the division in the parallel of these planes, you ultimately obtain an octohedron; which is the primitive form of fluor spar. A similar nucleus may be extracted from every crystallized variety of the same substance; and hence this is called its *primitive form*.

Having arrived at the primitive form of any crystal, in most instances the division may be continued in the parallels of the same planes to any extent; but in no other direction: this division consequently does not alter the form. But some primitive forms are divisible in planes that are not parallel to their surfaces; and, when this is the case, a solid figure is extracted which differs from the primitive form of the crystal to which it belongs. M. Haüy calls this the *integrant molecule*.

The forms of the integrant molecule are three: the tetrahedron, the triangular prism, and the parallelepiped: and it seems probable that every crystal is made up of a vast number of these integrant molecules; and that the different varieties of crystals have been produced by a variation in the arrangement of these. This supposition may be illustrated by taking a great number of small cubes for instance, and so arranging them as to form a larger cube, or an octahedron, or any other form; which may be easily effected. Such a process may be traced by the eye in many crystals; particularly in those of fluor spar. All those crystals which are variations of the primitive form are called *secondary*; but this with reference to form merely: for in their chemical composition they are exactly the same.

The term secondary has however been applied to certain crystallizations possessing a form not belonging to the nature of their substance. These are also called, and with more propriety, *pseudo-morphic crystals*; and appear to have been formed by a deposition of the particles of the pseudo-crystal, either immediately on the surface, or in the mould of the crystal of some other substance. Suppose, for instance, a quantity of any plastic substance were to be moulded on a natural crystal; and, the crystal being removed, a quantity of wax were to be poured into the mould; it is evident that the wax would thus acquire the form of a substance differing very much from itself in quality.

Sometimes

Sometimes the confusion produced in the process of crystallization is so great, that the crystallized form is to the senses entirely lost; as when crystals become lenticular, and lose the character so distinctive of their nature, namely their termination in straight lines bounding plane surfaces; or when they are so closely and intricately aggregated as to give rather a regularity and peculiarity of internal structure, than of external form.

Of the preceding characters of mineral substances, their hardness, phosphorescence, electricity, and their refractive power with respect to the rays of light, are called *physical*.

The *matrix* of a mineral is the substance in which it is immediately imbedded; or through which it is disseminated.

It has been already said that no systematic arrangement of minerals has reached us from the ancients, and there is good reason to believe that none ever existed. The modern systems, from the year 1730 to the present time, are no less than seventeen, besides the improved one of Gmelin, which we follow, as being substituted by him for that of Linnæus in his edition of the *Systema Natura*. It will not be expected that we should enter into the merits or demerits of these various systems, since we have declared which we prefer and adopt; but, for the sake of those who may wish to gain information from the valuable works in which they are detailed, we shall enumerate them in the order of time.

1. The system of Bromel, published at Stockholm, in an octavo volume, in the year 1730. The Bromelian method can hardly be called a system, as he has omitted the classification, the generic character, the specific differences, and the synonymes.

2. Linnæus's first system; Leyden, 1736, 1748.

3. Wallerius's first system; Stockholm, 1747. Of this system Linnæus thus speaks: "He first determined rightly the species in the mineral kingdom; and

and resolved in a beautiful manner the analysis of stones."

4. Woltersdorf; Berlin, 1748, 4to. His opinions are principally these: That soil, proceeding from vegetable or animal substances, passes gradually into clay; that all rock, when struck against steel, gives out sparks; that pumice-stone is not the product of volcanoes; that true native iron no-where exists. He observes in his Preface, "Linnæus was doubtless the first who, according to the laws of system, endeavoured to reduce the science of mineralogy into classes and orders."

5. F. A. Cartheuser; Frankfort, 1755, 8vo.

6. J. H. G. Just; Goettingen, 1757.

7. The system of Cronstedt; Stockholm, 1758. This system is merely metallurgic, investigated upon chemical principles; peculiar, and not compiled. Many genera are therefore excluded, as Sand-stone, Schist; Soil; Calculus, Nitre, &c. He denies that crystals originate from salts, and considers their figures rather curious than useful. Characteristic definitions he considers useless.

8. System of D. R. A. Vogel; Leipzig, 1762, 1776.

9. Linnæus's second system; Stockholm, 1768. In each of his systems, Linnæus divided this kingdom into three classes only—Rocks, Minerals, and Fossils.

10. Wallerius's second system; Stockholm, 1772. It differs but little from his first.

11. Veltheim's system, published at Brunswick, fol. 1781.

12. Bergman's; at Leipzig and Dresden, 8vo. 1782.

13. Kirwan's Elements of Mineralogy; London, 1784, 1790.

14. Werner's Mineral System; Freyberg, 1789. This has been much applauded.

15. System of Schmeisser; Lond. 1795.

16. System of Babington; Lond. 1796.

17. Kidd's Outlines of Mineralogy; Oxford, 1809. This system is formed upon that of Kirwan, with some judicious alterations, and including the new discoveries.

Gmelin's edition of the *Systema Naturæ* of Linnæus was published at Leipzig in 1793; wherein we have the following

CLASSIFICATION OF THE MINERAL KINGDOM.

MINERALS are divided into Five Classes; viz. Earths, Salts, Inflammables, Metals, and Petrifications.

CLASS I. EARTHS.

Stones, as they evidently have their origin from hardened compact Earths, into which they again moulder, cannot without unnatural separation but be joined with them in the same class. They resist fire, the greatest degree of which is not able to resolve any of their particles into vapour. They are all of them without taste, and most of them without odour. This class is divided into Seven Orders, which are subdivided into Genera, as under.

Order I. TALCOSA, are most of them soft and very soft, principally contain Magnesia alba, and never have the vestiges of living bodies. They occur in primary mountains, more often in secondary, some compose strata or the principal parts of mountains, and others are parasitical. By the action of fire they are not calcined, nor, except Hornblenda, Actinotus, and ferriferous Asbestus, are they liquefiable, but become harder. This Order contains the following Genera:

Talcum - - -	Greasy to the touch.
Serpentinus - -	Dry and harsh, of a shivery fracture, without lustre.
Asbestus - - -	Dry, fibrous without lustre.

Actinotus

Adinotus - - - Dry, shining.

Hornblenda - - - Dry, lamellous, black.

Order II. PONDEROUS. These exceed all others in specific gravity, are more easily liquefiable by fire, always parasitical, never have the vestiges of living bodies, are soft and hardish, and chiefly consist of *Terra ponderosa* properly so called. Contains the four Genera following:

Barytes - - - Soluble in boiling sulphuric acid.

Crostopetra - - - Not totally soluble in sulphuric acid.

Strontia - - - Soluble in marine and diluted nitric acids.

Sydneia - - - Soluble in muriatic acid.

Order III. CALCAREOUS. Some are formed of testaceous substances and corals, some are primitive, others are rupestral or parasitic, many are filled with the vestiges of living bodies; they are very soft, soft, and hardish; become more porous by fire; the purer ones all effervesce, and are almost totally dissolved in nitrous acid or aqua fortis. Contains 20 Genera:

Creta - - - - Soiling the fingers.

Tophus - - - - Porous, precipitated from water.

Spatum - - - - Lamellar, breaking into rhomboidal fractures.

Schistospathum - - - Undulately flaty.

Inolithus - - - - Fibrous, soluble entirely, with effervescence, in nitric acid.

Stalactites - - - - Precipitated from water in the air.

Pisolithus - - - - Consisting of globular granulations.

Marmor - - - - Compact or granular.

Suillus - - - - Emitting an urinous smell when scraped.

Tremolites - - - - Radiate, partly soluble in nitric acid.

Stellaris - - - - Fibrous in a stellate manner, easily melting in fire.

Humus - - - - Friable, becoming very pale when dry.

Marga - - - - Hardening by fire, and vitrifying in a greater degree of heat.

Magnefiata - - - - Becoming black in the fire.

Picrospatum - - - - Lamellar, brittle, slowly effervescing with acids.

Gypsum - - - - Calcinable with water, hardening in the air.

Hepaticus - - - - When scraped or exposed to heat, smelling like liver of sulphur.

Fluor

- Fluor - - - - Infused in hot sulphuric acid emits a gas which corrodes and dissolves glass.
 Apatites - - - - When sprinkled on red hot charcoal emits a green phosphorescent flame, not easily melted.
 Boracites - - - - Cubic, hard, semi-transparent.

Order IV. ARGILLACEOUS. Of these some are very soft, plastic, sticking to the tongue, when moistened give out a peculiar odour, hardening in the fire, and have often the impressions of animals and vegetables upon them; some are soft or hardish, and are rather liquefied than hardened by fire, of which the principal part are rupestral; others, though fewer in number, are hard, and undergo the same change by fire. Twelve Genera are included in this order, viz.

- Aluminaris - - - - Dry and harsh, soluble almost entirely in nitric acid.
 Argilla - - - - Greasy to the touch, plastic, hardening by fire.
 Puteolana - - - - Friable, hardening in the air when kneaded with water and quicklime.
 Cæmentum - - - - Solid, hardening in the air when pounded and kneaded with water and quicklime.
 Cariosus - - - - Rough, falling into powder in water.
 Ardesia - - - - Fissile, when moistened giving out an argillaceous odour.
 Basaltes - - - - Opake, without lustre, compact, of a dull colour, easily mouldering into pieces, melting into a blackish glass before the blowpipe.
 Lava - - - - The produce of volcanoes or subterraneous fires.
 Mica - - - - Scaly, shining.
 Opalus - - - - Of indeterminate shape when broken, compact, melting with the greatest difficulty.
 Zeolithus - - - - Easily melting with ebullition, and in melting emitting a phosphorescent light.
 Scorlus - - - - Melting, but emitting no phosphorescent light.

Order V. SILICEOUS. These are hard and very hard, and, except the fluoric, are not affected by acids, certainly in part; some are rupestral, others parasitic,
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and these last have often the vestiges of living bodies. This order contains seventeen Genera :

- | | | |
|----------------|---------|--|
| Gemma | - - - | Crystalline, hard and very hard, shining in the dark. |
| Olivinus | - - - | Easily falling to pieces in the air, melting with great difficulty. |
| Feldspathum | - - | Lamellar, melting with soda into a transparent glass : mouldering in the air. |
| Pyromachus | - - | Not mouldering in the air, or melting without the greatest degree of heat, breaking into convex fragments. |
| Petrofalex | - - - | Melts without ebullition, of shivery fracture. |
| Jaspis | - - - - | Opake, changing its colour in the fire, not melting by itself, breaking into convex fragments. |
| Lazulus | - - - | Hardish, opake, of a sky-blue colour, not losing its colour or effervescing by acids sprinkled upon it. |
| Smiris | - - - - | Of no determinate shape, melting with great difficulty, very hard. |
| Circonius | - - - | Ponderous, very shining within, breaking into incurved plates. |
| Amarus | - - - | Tenacious, green, of shivery texture. |
| Lydius | - - - - | Fissile, opake, of a dull colour, and of shivery texture. |
| Chlorogranatus | - | Green, crystalline, easily melted by fire. |
| Arena | - - - - | Consisting of dry hard rough granulations. |
| Quartzum | - - - | Resisting the greatest degrees of heat, and all acids except the fluoric : fragments angular. |
| Chalcedonius | - - | Resisting the greatest degrees of heat, and all acids : fragments more convex. |
| Adamas | - - - - | Very hard, evaporating in fire with a flame. |

Order VI. ADAMANTINE. Very hard, parasitical, containing an earth peculiar to itself, and hitherto detected in no other fossil. This order contains at present but one genus :

- | | | |
|-------------|-----|---------------------------------------|
| Adamantinus | - - | Resisting heat, fixed, hard lamellar. |
|-------------|-----|---------------------------------------|

Order VII. AGGREGATE. These may be taken as a mixture of the preceding Orders, and consist chiefly of particles, more or less crystalline, adhering by a cement often not visible. The Genera are six :

Granites

OF MINERALS.

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- Granites** - - - Consisting of granular particles united together without visible cement and without regular order.
- Gneissum** - - - Of a lamellar texture.
- Porphyrius** - - - Crystalline particles imbedded in a stony paste.
- Amygdalytes** - - - Glandules more or less rounded imbedded in a stony mass.
- Breccia** - - - Fragments of stone conglutinated by a stony or metallic cement.
- Arenarius** - - - Granulations of siliceous stones conglutinated by a stony or metallic cement.

CLASS II. SALTS.

These, by their taste and solubility in water, are known from all other mineral substances, and are distinguished among themselves by the kind of taste, and the degree of their solubility. Of this Class there are eight Genera:

- Natrum** - - - Of caustic taste; effervescing with acids.
- Borax** - - - Frothing in the fire, and in a strong heat melting into a transparent glass.
- Muria** - - - Of a salt taste, easily soluble in water, changing nitrous acid into the nitro-muriatic acid.
- Nitrum** - - - Of a cool sharpish taste, when moistened with very strong sulphuric acid emitting red vapours.
- Mirabile** - - - Producing liver of sulphur in a white heat with powdered charcoal: its watery solution not rendered turbid by a mixture of carbonat of soda.
- Amarum** - - - Of a bitter taste: its watery solution becoming milky by a mixture of carbonat of soda.
- Alumen** - - - Of a sweetish and very astringent taste: its watery solution not made turbid by prussiat of soda.
- Vitriolum** - - - Of an acid astringent taste: its watery solution made turbid by a mixture of carbonat of soda or prussiat of soda.

CLASS III. INFLAMMABLES.

Are characterized by their solubility in oil, by their

Taste

Smoke

smoke or flame when burnt, which is either grateful or disagreeable, innocent or deleterious, and by their colour or tint. This Class contains seven Genera :

- Turfa** - - - Consisting of vegetable fibres interwoven together and penetrated with bitumen.
- Bitumen** - - Giving out a faint disagreeable smell when burnt.
- Mellites** - - - Of a honey yellow colour, in the form of small eight-sided crystals.
- Succinum** - - Melting with difficulty; and emitting an agreeable smell during ignition, becoming electric by friction or heat.
- Ambra** - - - Softening and melting like wax in a gentle heat, and emitting a strong agreeable smell when warm; not becoming electric.
- Graphites** - - Burning with difficulty, but mixed with soda emitting reddish flames and sparks, staining the fingers black.
- Sulphur** - - - Burning with pale blue flames, and emitting during combustion strong suffocating peculiar fumes.

CLASS IV. METALS.

Metals are known by their lustre, great weight, proper flux, and solubility in acids.

Malleable.

- Platinum** - - Silvery-white; very hard and tenacious; sonorous; exceedingly malleable and ductile; not melting in a white heat; soluble only in 16 times its weight of boiling nitro-muriatic acid, and giving first a yellow and then a deeper red or brown colour to the solution.
- Aurum** - - - Reddish-yellow; hardish and tenacious; not sonorous; exceedingly malleable and ductile: melting in a white heat; soluble only in nitro-muriatic acid, and giving the solution a yellow colour.
- Argentum** - - Silvery-white; hard and tenacious: sonorous; exceedingly malleable and ductile; melting in a white heat; soluble in nitric acid, and imparting no colour to the solution.
- Hydragrum** - Silvery-white; fluid at the common temperature of the atmosphere: malleable when rendered

rendered solid by a sufficient degree of cold; evaporating in heat; soluble in mineral acids, and imparting no colour to the solution.

- Cuprum** - - Fine red; hard and tenacious; sonorous; malleable and ductile; when exposed to a red heat taking fire and emitting a most brilliant lively green light; exploding violently when melted and cast into water.
- Ferrum** - - - Bluish-grey; very hard, tenacious, and elastic; exceedingly malleable; ductile, attracted by the magnet; melting in a white heat; soluble in all acids, and giving the solution a black colour when vegetable astringents are added to it.
- Stannum** - - Silvery-white; softish; very malleable and ductile; not sonorous; flexible, and crackling when bent; melting easily; soluble in all acids, and giving the solution a bitter taste.
- Plumbum** - - Bluish-white; soft; not sonorous; very malleable, and a little ductile and tenacious; easily melting, and during liquefaction exhibiting iridescent colours on the surface; soluble in all acids, and giving the solution a sweetish taste.
- Niccolum** - - Reddish-white; hard; malleable; assuming a green colour when heated, and acquiring a purple tinge if the heat be continued; attracted by the magnet; soluble in all acids, and giving the solution a green colour.
- Zincum** - - Brilliant white with a shade of blue; hardish; a little malleable, but not ductile; slightly sonorous; of a fibrous or scaly texture; taking fire when heated to a strong degree, burning with a brilliant white flame and emitting light white flakes; soluble in all acids, and imparting no colour to the solution.

Brittle.

- Bismutum** - - Reddish-white, soft, brittle, of a lamellar texture; easily melting; taking fire when heated to a strong red degree, burning with a faint blue flame and emitting a yellow smoke; depositing a white precipitate if

if its solution in nitric acid be diluted with water.

Stibium - - Greyish-white; very brittle; of a lamellar and radiated texture; melting in a red heat, and becoming first a greyish-white oxyd, afterwards an hyacinthine glass, and at last evaporating in a white vapour; depositing a white precipitate if its solution in muriatic acid be diluted with water.

Tellurium - - Bluish white; very brittle; of a laminar texture; easily melting, and boiling and evaporating if the heat be increased; burning before the blowpipe with a lively blue flame the edges of which are green, and at last evaporating in a white smoke; depositing a white precipitate if its solution in nitro-muriatic acid be largely diluted with water.

Arsenicum - - Bluish-white; extremely brittle; subliming in a white powder in a moderate heat without melting, and emitting a strong smell resembling garlic; its sublimed powder giving its solution in water an acid taste, and turning vegetable blues red.

Cobaltum - - Bluish-grey with often a shade of red, hardish, very brittle; melting with difficulty, burning in a violent heat with a red flame; attracted by the magnet; giving a red colour to its solution in nitric acid, and precipitating a blue powder with the addition of potash.

Magnesium - - Iron-grey or brown, opaque, hard, very brittle, melting with great difficulty; attracted by the magnet when reduced to powder; mixed with nitre and exposed a sufficient time to heat, the mixture when thrown into water exhibiting a green, then a purple, then a scarlet colour, all which at last disappear.

Tungstenum - Brownish-red, internally bluish, brittle, extremely hard; not attracted by the magnet; melting with great difficulty, when heated is gradually converted from a black to a yellow oxyd, which assumes a blue colour with the muriatic acid.

Molybdænum - Iron-grey, brittle, composed of scaly particles; melting with great difficulty, gradually

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- ally becoming a white volatile oxyd when heated, which with the addition of borax is reducible to a violet glass.
- Uranium - - Dark-grey inclining internally to brown, soft, opake, melting with extreme difficulty; convertible into a yellow powder by means of the nitric acid.
- Titanium - - Orange red, very hard, in minute agglutinated grains; not fusible by any known heat, forming a blue or purple oxyd when heated.
- Chromium - - White with a shade of yellow, very brittle; melting with difficulty, dissolving slowly in acids; gradually becoming a green oxyd when heated in a close vessel.
- Columbium - - Dark brown-grey, hardish, very brittle, of an imperfectly lamellar texture; yielding when pounded a dark chocolate-brown powder, which is not attracted by the magnet; yielding a black powdery oxyd when exposed to a very violent heat.
- Tantalum - - Blackish-grey, softish, of a granular fracture, not soluble in any acid, nor altering its colour when heated to redness; yielding a white powdery oxyd.

CLASS V. PETRIFACTIONS.

These are not fossils of themselves, but animals and vegetables, or their parts, changed into a fossile substance. There are eight Genera, viz.

- Anthropolithus Man or the parts of man,
 Zoolithus - - Mammalia or their parts.
 Ornitholithus - Birds or their parts.
 Amphibiolithus Amphibia or their parts.
 Ichthyolithus. - Fishes or their parts.
 Entomolithus Insects or their parts.
 Helmintholithus Worms or their parts.
 Phytolithus - Vegetables or their parts.

CLASS I. ORDER I. TALCOSE EARTHS.

TALCUM, TALC, &c.

GENERIC characters: They consist principally of carbonat of magnesia, with silica and carbon.
 They

if its solution in nitric acid be diluted with water.

- Stibium** - - Greyish-white; very brittle; of a lamellar and radiated texture; melting in a red heat, and becoming first a greyish-white oxyd, afterwards an hyacinthine glass, and at last evaporating in a white vapour; depositing a white precipitate if its solution in muriatic acid be diluted with water.
- Tellurium** - - Bluish white; very brittle; of a laminar texture; easily melting, and boiling and evaporating if the heat be increased; burning before the blowpipe with a lively blue flame the edges of which are green, and at last evaporating in a white smoke; depositing a white precipitate if its solution in nitro-muriatic acid be largely diluted with water.
- Arsenicum** - - Bluish-white; extremely brittle; subliming in a white powder in a moderate heat without melting, and emitting a strong smell resembling garlic; its sublimed powder giving its solution in water an acid taste, and turning vegetable blues red.
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- Magnesium** - - Iron-grey or brown, opaque, hard, very brittle, melting with great difficulty; attracted by the magnet when reduced to powder; mixed with nitre and exposed a sufficient time to heat, the mixture when thrown into water exhibiting a green, then a purple, then a scarlet colour, all which at last disappear.
- Tungstenum** - - Brownish-red, internally bluish, brittle, extremely hard; not attracted by the magnet; melting with great difficulty, when heated is gradually converted from a black to a yellow oxyd, which assumes a blue colour with the muriatic acid.
- Molybdænum** - Iron-grey, brittle, composed of scaly particles; melting with great difficulty, gradually

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 Entomolithus Insects or their parts.
 Helmintholithus Worms or their parts.
 Phytolithus - Vegetables or their parts.

CLASS I. ORDER I. TALCOSE EARTHS.

TALCUM, TALC, &c.

GENERIC characters: They consist principally of carbonat of magnesia, with silica and carbon.
 They

They are soft, greasy to the touch, not admitting a polish; hardening in the fire, not effervescing with nitric acid, absorbing oil. This genus consists of eleven species, the chief of which are,

SEA FROTH, *Talcum spuma maris*.

Specific character, whitish, tenacious; hardening in the air. Found in small veins, covered with soil, in Anatolia, near Coni, Thrace, Greece, and North America. Colour white and yellowish white: consistence waxy when fresh: adheres to the tongue, and absorbs water: specific gravity 1.600. It is used to make the bowls of Turkish tobacco-pipes.

FULLERS EARTH, *Talcum fullonum*.

Tinged, tenacious. Found in Cornwall and Bedfordshire, Portugal and Saxony, in large masses under the common soil: colour yellowish or greenish-grey, greenish-white, green, or flesh-colour. Is used to take spots of grease out of cloth.

MARTIAL MURIATIC SPAR, *Talcum porcellanum*.

White with a cast of green, tenacious, forming porcellane in a greater degree of heat. Found in Lorraine at the depth of thirty feet, in strata of seven or eight feet; and is used by potters in the manufacture of porcelane.

CHEORITE OF PEACH, *Talcum chlorites*.

Friable, scaly, green, gives an earthy smell when breathed upon, melting with a greater heat into a dark brown glass. It is found in Swisserland and Saxony, in primitive mountains and rock crystal: colour grass or dark-green: has a scaly texture and glittering appearance.

COMMON TALC, *T. cosmeticum*.

Somewhat flexible, diaphanous, undulately lamellous,

lous, shining, breaking into discoid fragments. Found in Naples, Saxony, Silesia, Tyrol, and Sweden: colour pale green, silvery, greenish grey, green, red, yellow, or yellowish: strongly heated it becomes whiter, less transparent, and more brittle.

SPANISH CHALK, *Talcum brianzonicum*.

Rigid, without transparency, leaving a mark, very minutely lamellous. It is found in amorphous masses in France and Spain: colour white or greenish: absorbs but does not diffuse itself in water; hardens and whitens in the fire: contains silica 43.42, magnesia 20.84, alumina 14, iron 1, air and water 16.

STEATITE, OR SOAP-STONE, *T. smectis*.

Rigid, without transparency, shining when rubbed, leaving a white mark, of shivery fracture, subdiaphanous, apyrous. It is found in Cornwall, China, Norway, Sweden, Saxony, and Germany: colour white, or greenish-white, greyish-green, yellowish, or reddish, sometimes veined: does not adhere to the tongue: soft and soapy, and may be cut into any shape. It melts with borax and soda into a greenish slag.

POT STONE, *T. ollaris*.

Rigid, opaque, without transparency, undulately lamellous, breaking into discoid fragments. Found imbedded in amorphous masses in Russia, Norway, Saxony, and many parts of Europe: colour pale yellowish, or greenish-grey, reddish-grey, or speckled with red, and contains many micaceous particles: does not diffuse itself in water, but gradually crumbles to pieces: is brittle and too hard for writing, but is made into utensils for holding water.

SERPENTINUS, SERPENTINE.

CONSISTING of carbonat of magnesia, oxyd of iron, and silica, with frequently a mixture of alumina,
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rarely of calcareous earth : dry and harsh to the touch, receiving a polish : hardening in the fire ; neither effervescing with nitric acid nor absorbing oil. There are four species.

JADE OR NEPHRITE, *Serpentinus nephriticus*.

Leek-green, semipellucid, a little greasy to the touch. It is found in Egypt, America, Sweden, Saxony, Bohemia, and the Siberian and Hungarian mountains ; sometimes adhering to rocks, and sometimes in detached rounded pieces : colour dark leek-green, with often a bluish cast : is very hard, and does not melt in the strongest fire. The inhabitants of New Zealand use them for hatchets and other cutting instruments.

SERPENTINE, *S. genuinus*.

Opaque, without lustre, of splintery fracture, becoming whiter in the fire. Found in most European mountains, generally in large amorphous masses : colour blackish, leek, olive or canary green, yellow, red, grey, brown, white, or blue ; one specimen generally exhibiting a mixture of several colours, like the skin of a serpent : when breathed upon, frequently emits an earthy smell.

ASBESTUS, ASBESTUS.

CONSISTING of carbonat of magnesia, silica, and generally alumina ; with frequently oxyd of iron, rarely carbonat of lime : dry to the touch, fibrous, soft, light and floating, brittle in the fire, parasitic.

The words *Asbestus* and *Amianthus* are used indifferently for this genus ; the former term signifying *unextinguishable*, or rather *imperishable* ; the latter *unstained*, or *unsoiled* ; both denoting the very singular properties of all the species. The industry of mankind has found a method of working this untoward mineral, and employing it in divers manufactures, chiefly of
cloth

cloth and paper. The cloth of asbestus was highly esteemed by the ancients, and held equally precious with the richest pearls. Pliny says, he himself had seen napkins thereof, which, being taken foul from the table after a feast, were thrown into the fire, and by that means were better scoured than if they had been washed in water. But its principal use, according to Pliny, was for making shrouds for royal funerals, to wrap up the corpse, so that the ashes might be preserved distinct from those of the wood whereof the funeral pile was composed; and the princes of Tartary, according to the Philosophical Transactions, use it at this day in burning their dead. Some of the ancients are said to have made themselves clothes of it, particularly the brachmans among the Indians. The wicks for their perpetual lamps, according to Dr. Lister, were also made of it: because, the asbestus not wasting, there is no occasion for shifting the wick. Although the cloth of asbestus, when soiled, is restored to its primitive whiteness by heating in the fire, it is found, nevertheless, by several authentic experiments, that its weight diminishes by such treatment. A handkerchief or pattern of this linen was long since presented to the Royal Society, a foot long and half a foot broad. This gave two proofs of its resisting fire; though, in both experiments, it lost above three drachms in its weight. When taken out red-hot, it did not burn a piece of white paper on which it was laid. The method of preparing the incombustible paper and cloth, from asbestus, is thus described by Ciampini: The stone is laid to soak in warm water; then opened and divided by the hands, that the earthy matter may be washed out. The ablution being several times repeated, the flax-like filaments are collected and dried; and they are most conveniently spun with an addition of flax. Two or three filaments of the asbestus are easily twisted along with the flaxen thread, if the operator's fingers are kept oiled. The cloth also, when

woven, is best preserved by oil from breaking. On exposure to the fire, the flax and the oil burn out, and the cloth remains pure and white.

There are ten species of Asbestos, in two divisions. We shall describe the most remarkable in each.

I. *With all the fibres parallel.*

MOUNTAIN FLAX, OR FLEXIBLE ASBESTUS, *A. amianthus.*

Specific character, floating with very fine, separable, highly-flexible, fibres. Found with Serpentine in the Ural, Lapland, Swedish, and many European mountains, and likewise in Candia and China: colour silvery-white, greyish, greenish-white, yellowish, pale flesh-colour or ochre yellow: feels a little greasy to the touch: and easily melts in a candle.

COMMON ASBESTUS, *A. vulgaris.*

Without lustre, with rigid stony cohering fibres in long bundles. Found in Siberia, Lapland, Sweden, Silesia, Saxony, Franconia, and Tyrol, generally in wedge-shaped pieces: colour green or grey: its surface can be scratched with a knife, and is not altered by fire: it melts with borax into a white glassy mass.

II. *With the fibres interwoven, and breaking into obtuse-angled fragments.*

MOUNTAIN CORK, OR ELASTIC ASBESTUS, *A. suber.*

Flexible, resembling cork, imbibing water with a noise, adhering to the tongue. Found in the mines of Sweden, Saxony, Hungary, &c. containing often silver ores, in thick compact pieces: colour white, reddish-white, cinereous, greenish, or yellowish: the fibres are so confusedly interwoven with each other, and sometimes so subtilly, as to be distinguished with difficulty: it is very light, dry, and elastic, and yields to the pressure of the nail.

MOUNTAIN

MOUNTAIN WOOD, or LIGNIFORM ASBESTUS,
A. lignum.

Resembling wood in colour and texture. Found at Clausen, in Tyrol: colour brown, and if broken across discovers an irregular filamentous structure like wood.

MOUNTAIN LEATHER, *A. caro.*

Flexile, floating, in thick-lamellar pieces. Found in the iron-mines of Sweden, in pieces of the thickness and consistence of tanned horses' skin: colour whitish, the outer surface often consisting of very thin short crowded erect hairs, over which is a black unequal membrane. It has the appearance of a hornblend, but is immediately distinguished by its softness and colour.

ACTINOTUS, ACTINOTE.

CONSISTING of carbonat of magnesia, a larger proportion of oxyd of iron, and the greater part silica: harsh to the touch, shining, rigid, fragile, parasitic, generally of a green colour, spontaneously falling into granular fragments, but breaking into indeterminate fragments: melting in the fire, with ebullition, into a pellucid fix-coloured globule. There are three species.

FIBROUS ACTINOTE, *Actinotus fibrosus.*

Opake, soft, shining within, fibrous with the fibres diverging. Found with pyrites in the mines of Saxony, of a glassy lustre, sometimes greyish-white, greenish or reddish-white, or cinereous: feels a little greasy to the touch.

COMMON ACTINOTE, *A. vulgaris.*

Shining, hardish, pellucid or diaphanous, radiate or striate. Found in the iron-mines of Sweden, the quarries of Saxony, and the mountains of Franconia and Tyrol, in long flatish four or six-sided crystals, which are brittle and not flexible: feels very slightly, if any thing, greasy to the touch: colour greenish-white or reddish

reddish grey: it often constitutes the matrix of metallic ores.

GLASSY ACTINOTE, OR MALACOLITE, *A. vitreus*.

Of a glassy lustre, semi-transparent, hardish, somewhat fibrous. Found on the Island of Sky in Scotland, near Allemont in Dauphiné, and in the Tyrolose mountains, in solid masses, and crystallized in six-sided prisms: colour leek-green with a silvery lustre, or with a yellowish stain, or brownish-red: it breaks longitudinally into long sharp splintery fragments, discovering its closely-adhering quadrangular or hexangular fibres.

HORNBLENDA, HORNBLENDE.

CONSISTING of carbonat of magnesia, an equal portion of oxyd of iron, and a nearly equal quantity of carbonat of lime: soft, opaque, generally of a dull colour, leaving a streak, lamellous, breaking into indeterminate fragments: melting in the fire, with ebullition, into a black opaque globule. There are three species.

COMMON HORNBLENDE, *H. vulgaris*.

With hardly any lustre, of a dull colour when broken in any direction, and exhibiting lamellar pieces or rays. Found in Sweden, Saxony, Portugal, Bohemia, and most European mountains. In solid masses, interspersed with other stones; sometimes crystallized in six or eight-sided prism: it is always either radiated or foliated, and the crystals are transversely striated: colour dull green or blackish: fracture straight, or curved, or divergingly striate.

LABRADORE HORNBLENDE, *H. Labradorica*.

Subopaque, with a little lustre, in curved lamellar pieces, which when broken discovers a coppery-black internal surface. Found in scattered pieces in the island of St. Paul, on the Labradore coast: colour greyish-

greyish-black, with sometimes a shade of coppery-red or iron-grey, according to the direction of the light: fracture mostly curved and foliated.

BASALTIC HORNBLENDE, *H. basaltina*.

Shining, hardish, leaving a greyish-white streak, when broken longitudinally exhibiting straight lamellar pieces, crystallizing into small six and eight-sided prisms terminated by three-sided pyramids. Found in Basalt, Tuffe, Wacke, and Lavas, in most parts of Europe, to which it adheres very closely: colour black, greenish black, dark green, or yellowish-green; of a shining surface when broken: melts before the blow-pipe into a greyish enamel with a tinge of yellow.

ORDER II. PONDEROUS EARTHS.

BARYTES, BARYT.

GENERIC characters, it consists almost entirely of ponderous earth; is ponderous, parasitic, very brittle, harsh to the touch, soft: entirely soluble in boiling sulphuric acid; in the fire at first deprived of the cohesion of its parts, and afterwards melting without ebullition. There are eight species, in two divisions.

1. *Combined with carbonic acid gas, which does not totally disengage itself during liquefaction, and therefore effervescing with acids.*

BARYT, or WITHERITE, *B. witheringii*.

Specific characters, of a common figure and equal texture. Found at Anglezark near Chorley in Lancashire, near St. Asaph in Wales, and in Argyleshire in Scotland, in solid masses and crystallized. Texture shining, radiated, fibrous: colour greenish-white or white: crystals small six-sided prisms terminated by six-sided pyramids: when heated, it becomes opaque. Its powder phosphoresces when thrown on burning coals: contains baryt 62, carbonic acid 22, water 16.

LAMELLAR

LAMELLAR BARYT, *B. lamellosa*.

Lamellar, of a crystalline figure, semi-pellucid, smooth on the outer surface, shining within. Varies with four and six-sided prisms. Found in Scotland, Lancashire, Yorkshire, and Saxony, in solid masses: colour white, with a degree of transparency.

II. *Saturated with sulphuric acid, and therefore not effervescing with acids: shining in the dark, after having been whitened in the fire.*

EARTHY SULPHAT OF BARYT, *B. terrestris*.

Friable, in an earthy loose or united form. Found in the lead-mines of Stafford and Derby, near Freyburg, and in the vicinity of Paris, in coarse dusty particles, mostly forming small concretions, seldom in the form of powder: has an arid appearance, feels coarse, rough, and harsh, and soils the fingers a little: colour snow-white, greyish, reddish or yellowish-white: it sometimes contains a little gypsum, filica, and lime.

COMPACT HEAVY SPAR, *B. compacta*.

Subopaque, shining, of a splintery fracture, with the fragments indeterminate and acutangled. Found in the lead-mines of Derbyshire and Staffordshire, and in Saxony, in amorphous or half-rounded masses, or in nodules; breaking into sharp angular pieces, and when broken has a dull appearance, with sometimes a little glittering: colour dull grey, yellowish-white or yellowish; cream-colour, pale flesh-colour, reddish, or bluish: contains sulphat of baryt 83.5, filica 6.7, selinite 2, water 2.

BOLOGNA STONE, *B. Bononiensis*.

Diaphanous, shining, somewhat fibrous, breaking into fragments more or less rhombic. Found on the mountain Paterno near Bologna, detached in roundish flat kidney-form pieces, the fragments of which are obtusangled, roundish, with the superficies unequal: broken in a certain direction it appears fibrous,
broken

broken in another it appears rather lamellous; sometimes falls to pieces spontaneously into granular fragments; colour smoke-grey, with a small degree of semi-transparency: contains by analysis sulphat of baryt 62, filex 16, alumine 14.75, gypsum 6, iron 0.25, water 2.

COMMON PONDEROUS SPAR, OR CAWK, *B. vulgaris*.

Lamellar, breaking into rhomboid fragments, falling spontaneously into convergent scales. Found in various parts of Britain and Europe, and is the most common matrix of metallic ores: it is sometimes found in powder, often in amorphous masses, often crystallized: it is sometimes highly polished, generally diaphanous, and in its crystallized state transparent and reflective. Colour snowy, silvery or bluish, greyish, greenish, reddish, or yellowish-white, often flesh-colour, smoke-colour, honey-colour, vinaceous, rarely olive-green, or greenish or yellowish-grey, or greyish-black, very rarely blue: the layers are generally straight, sometimes incurved. The primitive form of its crystals, according to Hauy, is a rectangular prism, whose bases are rhombs, with angles of $101^{\circ} 30'$ and $78^{\circ} 30'$. Contains, by analysis, pure barytes 67.2, sulphuric acid 32.8.

CROSSOPETRA, CROSSOPETRA.

CONSISTING of ponderous earth, a larger portion of filex, and a smaller of alumine: lightish, hard, parasitic, meagre, crystalline: not totally soluble in sulphuric acid, even in a boiling heat, melting with difficulty in the fire. There are but two species.

HERCYNIAN CROSSOPETRA, *C. Hercynica*.

In four-sided rectangular tables or prisms, transversely striate, terminating at one end in a needle point; two of them cutting each other crosswise, and

longitudinally. Found upon calcareous spar, in the mines of Hercynia, near Andreasburg, in smaller aggregate crystals, sometimes very minute, rarely pellucid, oftener diaphanous or opaque: colour milk-white, hyaline, yellowish, not always striking fire with steel, yet frequently making a mark upon glass: melts with borax and soda, with ebullition.

SCOTCH CROSSOPETRA, *C. Scotica*.

In four-sided tables or prisms, one end running into a needle point, and not united. Found in the mines of Scotland, near Strontian, and is distinguished by its larger crystals.

STRONTIA, STRONTIANITE.

CONSISTS of strontian earth combined with acids: separates from a saturated solution in nitric acid, in the form of rhomboidal crystals: totally soluble in nitric and muriatic acids, with effervescence: does not melt in a strong heat, but discovers a bright phosphorescent light. There are two species.

CARBONAT OF STRONTIAN, *St. carbonata*.

Combined with carbonic acid. Found in the lead-mine of Strontian in Argyleshire, in granite rocks, accompanied by Galena and Witherite, generally in amorphous masses, or in a state of crystallization: colour whitish-green; and has some lustre, and a little transparency: when exposed to heat it does not crackle or split, but before the blow-pipe becomes white and opaque: with borax it effervesces and melts into a colourless transparent glass: it is soluble in 200 parts of water, at a temperature of 60°; its solution tinges flame red: its crystals are confusedly grouped, and more or less diverging from a centre, and are usually six-sided prisms, terminated by three-sided pyramids.

SULPHAT

SULPHAT OF STRONTIAN, *St. sulphata*.

Combined with sulphuric acid. There are three varieties.

1. *Earthy Sulphat of Strontian*; opaque, brittle, compact, somewhat splintery, in round pieces, which is found at Montmartre near Paris, of a bluish-grey colour, without lustre.

2. *Fibrous Sulphat*; fibrous, with the fibres straight, somewhat transparent. This is found in many parts of Britain and Europe, in masses: colour pale blue, reddish, or white: externally it has little or no lustre, internally shining.

3. *Foliated Sulphat*; this is also fibrous, with the fibres diverging, texture of the crystals straight, foliated. Found in Britain and Sicily, in masses and crystals: the amorphous pieces fibrous, with the fibres diverging: crystals grouped, shining, semitransparent: colour white.

SYDNEIA, SYDNEY EARTH.

CONSISTS of ponderous earth, alumine, fine sand, and some colourless mica: soluble in heated muriatic acid only; the solution not crystallizing, but becoming a butyraceous and deliquescent mass: melts in a heat of 15° of Wedgwood.

There is but one species, called *Sydneia Australis*; being found in Sydney Cove, in New South Wales. It is white, with sometimes a few black particles resembling black lead. The butyraceous mass from the solution is pale yellow and not corrosive.

ORDER III. CALCAREOUS EARTHS.

The Earths of this Order consist principally of carbonat of lime.

CRETA, CHALK, LIME, &c.

CONSISTING of carbonat of lime and carbonic acid

acid gas, and a few extraneous substances: friable, effervescing with, and nearly totally soluble in, acids: calcining in the fire, but not vitrifying in the strongest heat. There are eight species; the most remarkable of which are:

NATIVE LIME, *Creta pulverulenta*.

Specific characters, reducible to dust, without lustre, rough to the touch, staining the fingers. It is found near Bath, white, without lustre or transparency, fracture earthy, and easily rubs to powder: when mixed with a little oxyd of iron, it becomes yellowish.

GARIC MINERAL, *Creta farinacea*.

Farinaceous, loosely cohering, floating, soiling the fingers. Found in Britain, and various parts, in the clefts of rocks, or the bottom of lakes, or calcareous mountains; it is formed of more compact particles, is exceedingly brittle, and reducible to dust; does not adhere to the tongue: colour white, reddish, or yellowish.

COMMON CHALK, *Creta scriptoria*.

Solid, rough, slightly adhering to the tongue, without lustre, opaque, staining the fingers, breaking into indeterminate fragments. Common chalk is found in large strata in various parts of Britain, Germany, France, and Sweden, particularly on some sea-coasts, often containing flints and the vestiges of echini and shells: colour generally white, rarely greyish: feels rather rough to the touch, and effervesces strongly with acids: contains carbonat of lime 95, alumine 2, water 3.

Chalk is employed as a remedy against the heart-burn, and other disorders that have acidity in the primæ viæ for their cause. Dr. Stare asserts from experiments, that it absorbs acid sooner, and more powerfully than crabs' eyes, calcined hartshorn, or coral.

coral. Some use it when finely powdered, to sprinkle on erysipelatous inflammations. When chalk is saturated with an acid, it is said to become subastringent, otherwise it hath no such property; hence chalk, given when acidity prevails in the stomach, sometimes produces costiveness; though this is much doubted by Cullen and others. Two drams for a dose, and repeated at proper intervals, have often effected a speedy cure, both in a diarrhoea and a dysentery; but this effect was owing to its absorbing those acrid juices whose stimuli caused the morbid excretion. When milk turns sour on the stomach, a scruple of chalk may be given with each half pint.

ARENACEOUS LIMESTONE, *Creta ganil.*

Solid, hardish, brittle, a little shining and transparent. This is found on the shores of Rhagbery, a small island on the coast of Antrim, and at Codrilla, on the west side of Vesuvius, yellowish-white. In the lump it cannot be easily broken, but in small pieces it fritters between the fingers: phosphoresces when scraped in the dark with a knife.

TOPHUS, TUFA.

CONSISTING principally of carbonat of lime: precipitated by water under water: porous, without lustre. There are eight species.

COMMON TUFA, *Tophus communis.*

Deposited at the bottom of cold waters running through mountains and calcareous strata. Found in every part of the globe, sometimes hardening in the air, sometimes mouldering; of numerous varieties with respect to colour, and often forming the first material of calcareous strata.

SANDY TUFA, *T. osteocolla.*

Calcareous, more or less cylindrical, perforated.

It

It is found in various parts of Germany, and elsewhere, both in brooks and under beds of sand, from the size of a crow-quill to the thickness of a man's arm: white or ash-colour, something in the shape of a bone, and was formerly supposed to have the quality of uniting broken bones, whence the name of *oste-colla*. It is mostly in long cylindrical pieces, sometimes irregularly tubular and porous, sometimes filled up with a marly earth mixed with sand, with often the remains of decayed roots of trees in the centre. The incrustations do not appear in regular concentric layers, but consist of thin strata spirally rolled up: when first found in the earth, it is soft and ductile, but in a very short time it hardens by exposure to the air: consists of sand and earth cemented by a calcareous deposition.

STALACTITIC TUFFA, *T. incrustans*.

Incrusting animal and vegetable substances with a calcareous coating, and assuming their figure. This species is found in various parts of Sweden, Germany, Italy, &c. clothing with a calcareous coat the smaller branches of trees, leaves, prickles, moss, plants, crabs, eggs, birds and their nests, preventing them from decay by defending them from the action of the atmospheric air. Most of those substances, which are commonly called *petrifications*, are of this species.

TEA-KETTLE TUFFA, *T. lebetum*.

Incrusting the bottom and sides of vessels in which water has been boiled. It is found very commonly on the bottom and round the sides of tea-kettles, and other vessels in which water has been often boiled, forming a thin hard incrustation. It is formed in much greater quantities from spring than from rain water, and is seldom without a portion of filix.

TOOTH

TOOTH TUSA, *T. dentium*.

Forming incrustations on decayed teeth. Found in scales, plates, or irregular-shaped lumps, on decaying teeth, and seems to be formed by deposition, in the same manner as the crust in tea-kettles. Its surface is very rough, and more or less porous.

TESTACEOUS TUSA, *T. testaceus*.

Consisting of the aggregate fragments of shells. Found in the neighbourhood of Syracuse, Palermo, and the promontory of Passoro in Sicily: white or yellowish-white, exceeding porous and brittle, formed of various shells broken and compacted together.

There is a variety, which is softer, and not so compact, called *Marly Tusa*; found in most parts of Europe, yellowish-white, resembling mortar, without lustre or transparency, and very porous: fracture earthy.

SPATUM, SPAR.

CONSISTING of carbonat of lime, a larger proportion of carbonic acid gas, and water: lamellous, shining, parasitical, soft, lightish, breaking into rhomboidal fragments: crackling in the fire. There are twenty-three species in three divisions.

I. *Of a common figure.*COMMON SPAR, *Spatum opacum*.

Opake, or nearly so. Found in Norway, Sweden, Germany, Switzerland, and Hungary, most commonly white, sometimes cinereous, bluish, greenish, yellowish, red, or blackish. There is a variety which changes its lustre with respect to its position in the light.

SHINING SPAR, *Sp. pellucidum*.

Pellucid, hyaline. There is a variety which doubles objects by refraction. This species is found
in

in Russia, Lapland, Norway, Sweden, and other mountainous parts of Europe; the variety, which doubles the object by refraction, chiefly in Iceland. Colour yellow or yellowish, olive, greenish, bluish, smoke-colour, blackish, rarely red or veined. When exposed to heat, it parts with its transparency and carbonic acid; and, after calcination, sometimes shines in the dark, if thrown upon hot coals.

II. Of a peculiar figure.

STALACTITIC SPAR, *Sp. stalactiticum*.

Of a more or less cylindrical form, one variety resembling a branch of coral. This species is found in Bohemia and Hungary, the coralliform variety plentifully in the loose marl at St. Mawe's, Cornwall, where it is used for manure, and in North Wales. Its appearance has so much the resemblance of a coral as to be commonly mistaken for such, but it appears on examination to be aggregations of calcareous earth ramifying in the soft marl: colour white, yellowish white, or pale ferruginous from a small mixture of iron.

III. Crystallized.

CALCAREOUS SPAR, *Sp. bracteatum*.

With six-sided tables. All the varieties of this species are found in limestone rocks in most parts of Europe. Colour white, rarely yellowish, pale brown, reddish, green, very rarely crimson, bluish, purple, or black: never quite opaque, but sometimes with a pearly lustre.

PEARL SPAR, *Sp. cubicum*.

With perfect cubic aggregate crystals. Found in limestone rocks, generally white, sometimes with a pale rosy lustre, and clustered together in various shapes.

shapes. It is harder than common carbonat of lime; and effervesces slowly with acids: but it is reducible to the primitive crystal. It becomes magnetic by the blowpipe, in consequence of the iron contained in it: and blackens by the same process, or by exposure to air, in consequence of the manganese contained in it. It is commonly met with in the form of veins, or a crystalline incrustation investing other minerals: the latter arrangement appearing to be the result of small flattened rhombs applied to each other in a curved direction, so as to give a foliated appearance. It is said by Mr. Jameson to be one of the principal vein-stones in the mining district of Freyberg, and to be considered as indicating the neighbourhood of rich silver ore.

RHOMBIC SPAR, *Sp. rhombeum*.

With aggregate cubic crystals, the faces of which are oblique-angled. A specimen in the Oxford collection consists of several rhombic crystals grouped together, some of them nearly an inch in diameter: they have externally a brown ochry incrustation; internally they are of a pearly lustre, yellowish colour, and nearly transparent. They blacken and become magnetic by the blowpipe; and in their chemical characters in general answer to rhomb-spar. Rhomb-spar is considered by some to be a variety of pearl-spar. It is found at Königsberg, in Norway; in Saxony; in the Tyrol; in Cornwall, and on the banks of Loch Lomond.

DOG'S-TOOTH SPAR, *Sp. hyodon*.

With a double six-sided pyramid. Of this species there are many varieties, most of which are found in the mines of Derbyshire and Cumberland, in Sweden, Hungary, and Germany: more frequently white than yellowish or with a tinge of green: sometimes pellucid, sometimes opaque: the crystals frequently very

small, rarely transversely grooved, and often placed in a regular series.

The remaining species consist of pyramids from three to twelve sides.

SCHISTOSPATUM, PLATED SPAR.

CONSISTING of carbonat of lime, a larger proportion of carbonic acid gas, and water: effervescing with acids: lamellar with the foliations curved, parasitical, soft, breaking into indeterminate fragments, lightish, a little greasy to the touch: crackling in the fire. There is but one species.

PLATED SPAR, OF ARGENTINE, *Sch. fissile*.

There are two varieties, one with the fibres curved, the other with the fibres undulate. The first found near Schwartzenburg and Konigsburg in Saxony, and in the spara pit in Norway; the second near Kopmanneficel in Sweden, in irregular masses and very brittle. Colour of both, greyish, reddish, or greenish-white, with a silvery greasy lustre, or similar to mother of pearl; sometimes opaque or nearly so; rarely diaphanous; may be scratched with the nail. When heated to redness it turns reddish-brown, and at a degree of 155 is converted partly into a brown porcelain mass, partly into a reddish-brown glass. Mr. Kirwan supposes it to contain carbonat of lime, filix, and oxyd of iron.

INOLITHUS, FIBROUS LIMESTONE.

CONSISTING of carbonat of lime, carbonic acid gas, and a little iron: entirely soluble in nitric acid with effervescence: fibrous, parasitic, soft, lightish, breaking into indeterminate fragments. There are four species.

FIBROUS LIMESTONE, OR ALABASTER, *I. filamentosus*.

With the fibres parallel. There is a variety with a rich satiny

satiny lustre, called *satın spar*. This species is found in Russia, Poland, Germany, Saxony, and Bohemia, with the fibres straight or a little curved: the *satın spar* is found about a mile from Alston in Cumberland, washed by the river Tyne, near the level of its bed. Colour white with sometimes a rosy tinge from a diluted mixture of oxyd of iron, and transmits light from the edges or in thinner pieces: fracture in the direction of the stræ fibrous, straight or curved. Specific gravity from 2.709, to 2.721; contains carbonic acid 47.6, carbonat of lime 50.08, water of crystallization 2.308, and sometimes iron 0.012.

STALACTITES, STALACTITE.

CONSISTING of carbonat of lime, carbonic acid, and water: formed in the air by the gradual deposition of water: diaphanous, without lustre internally, breaking into indeterminate fragments, and separating into concentric crusts: found chiefly on the roofs and sides of arches, and the caverns of calcareous mountains. There are four species.

LIME STALACTITE, *St. spatofus*.

Pendulous, lamellar internally, diaphanous. Found in various caves of limestone rocks in Britain, Germany, and other places, white, cinereous, brownish, or yellowish, and of various shapes. Water, in penetrating through marble or limestone strata, very commonly becomes impregnated in its passage with particles of the calcareous carbonat; which it subsequently deposits, either by simple exposure to air, or upon the surface of extraneous bodies with which it comes into contact: in the first instance giving rise to those formations called Stalactites, &c. in the last, to those earthy incrustations commonly called Petrifications. The most familiar instance of the deposition of calcareous matter from water is that which takes place on the inner surface of vessels employed for the purpose of boiling

boiling water impregnated with calcareous carbonat : it is called by Wallerius, Tophus calcareous lebetum ; the term tophus arising from its resemblance in lightness of texture to real tophi or volcanic productions. A similar deposition takes place, at a common temperature, upon the surface of tubes and reservoirs conducting and holding the same kind of water. The incrustation separated from the sides of Carfax conduit, in Oxford, (at the time of its removal, about twenty-five years since,) was nearly an inch in thickness ; and of a distinct sparry structure. There is, in the Oxford collection, part of a wooden duct that served to convey the water from this conduit : the transverse section of it is of a square form, and it is worthy of observation that the calcareous incrustation, which is of a stratified appearance, is of equal thickness on every one of the four surfaces : by which it appears, that a deposition of this kind is not merely mechanical ; nor does it necessarily follow, as some have argued, that such depositions accumulate according to the law of gravity : and hence there is no difficulty in supposing, that vertically-situated veins may have been sometimes formed by lateral and successive depositions.

COMMON STALACTITE, *St. stiria*.

Specific character, pendulous in concentric crusts, either cylindric or conic. The term stalactite is applied particularly to those calcareous concretions which are formed on the roofs of natural caverns ; and which resemble in their shape the common icicle. The matter of the stalactite as has been already stated, is conveyed by water that has penetrated the contiguous strata ; and in its deposition assumes various appearances according to accidental circumstances. If the water oozes through very slowly, some time elapses before a drop is formed of sufficient size to fall by its own weight ; and in this interval some of the calcareous

calcareous particles are separated from the water, and adhere to the roof. In this manner successive particles are separated and attached to each other, until a stalactite is formed. When the formation is rapid, the texture is comparatively loose, and of an earthy appearance; and this is particularly the case with those stalactites that are formed from recently-constructed arched buildings, as bridges, or cellars; where the stalactite is made up of thin concentric cylinders, like a roll of fine cinnamon. In other instances the substance is completely sparry; and, often, very closely resembles the transparent part of the quill of a bird's wing; and not unfrequently terminates in a spherical assemblage of small pointed crystals. In the generality of instances these depositions are of a light brown colour, and opaque; or of a dirty straw-colour, with some degree of transparency: the colour is probably owing to the presence of vegetable matter dissolved by the water in its passage through the soil. In other respects stalactitic carbonat of lime is purer than that of the strata from whence it is derived; the water not readily dissolving other earthy or any of the metallic matter contained in them.

Mr. Coxe, during his travels through Europe, never failed to observe that calcareous depositions abounded in all those districts where the disease called goitres was prevalent. Pallas mentions the coincidence of this disease, and of springs impregnated with calcareous carbonat, on the banks of the Volga: the same coincidence is well known in Derbyshire; and is met with frequently in Oxfordshire. It has often been observed in Sumatra; in which last place at least the origin of the disease cannot be referred, as it often is, to the custom of drinking snow-water. A paper, however, written by Dr. Reeve, in the *Philosophical Transactions* for 1808, controverts the truth of the supposition, that this disease arises from the use of water impregnated with calcareous carbonat.

STALAGMITE,

STALAGMITE, *St. stalagmites.*

Sessile, with spherical faces: the varieties are globular, nodulous, kidney-form, mamillary, &c. If the percolation of water containing calcareous particles is too rapid to allow time for the formation of a stalactite, the earthy matter is deposited from it after it has fallen from the roof upon the floor of the cavern; and in this case the deposition is called a *stalagmite*: a verbal distinction adopted merely for the convenience of description. Stalagmites are commonly, at least in the early stage of their formation, of a mamillary shape: by gradual accumulation they become conical. In some instances the separation of the calcareous matter takes place both at the roof and on the floor of the cavern; and, in the course of time, the substance of each deposition increasing, they both meet; and form an irregular but continued pillar. Local circumstances, and the degree of celerity with which the deposition takes place, vary the appearance of the effect produced; and hence those grotesque accumulations which have been described as representing the forms of various animate and inanimate substances: as the fancied figures of lions, &c. in some of the caverns near Buxton, and in other parts of Derbyshire. In the quarries of the island of Antiparos these depositions have been carried to a great extent: an account of the fantastic shapes of which is given in extravagant terms in a letter written to Kircher, inserted in his *Mundus Subterraneus*. We may add that stalagmitical depositions constituted the alabaster of the ancients.

PISOLITHUS, PEA-STONE.

CONSISTING of carbonat of lime, a very small proportion of sand and oxyd of iron, carbonic acid gas, and water: soft, opaque, without lustre internally, breaking into indeterminate fragments, and separating
into

into spherical granulations: of a centrically lamellar texture: found about warm springs. There is but one species, called, for what reason we know not,

CAROLINA PISOLITE, *P. Carolinus*.

Found near the warm springs of Carlsbad in Bohemia, in Silesia, and in Hungary, in the form of round masses, from the size of a pea to that of a walnut, composed of concentric layers, each containing a grain of sand in its centre: colour white or yellowish-white, brownish, reddish, or yellowish.

MARMOR, MARBLE, &c.

CONSISTING of carbonat of lime, carbonic acid gas, and water: hardish, meagre to the touch, of a common form, lightish, composing whole mountains, or the greater part of them, or in detached pieces: burning into quicklime, soluble for the greater part in acids, with effervescence.

The term *marble* was originally applied to any mineral substance capable of receiving a polish, and used, in consequence of the beauty of its appearance, for ornamental purposes: in the present instance it is applied to such mineral substances only, as from the nature and proportions of their constituent parts are justly denominated carbonats of lime.

The term *limestone* also, which strictly speaking is applicable to any natural compound containing a large proportion of that earth, is here used to express those natural compounds only, in which lime combined with carbonic acid is the principal constituent part.

In this sense then, marbles and limestones are with respect to their chemical analysis the same: they differ only in their uses and external characters. Almost all of them contain some portion of iron: many contain clay also; and, where the proportion of clay is considerable, the substance possesses those properties which

which constitute a marl. There are fourteen species, and many varieties.

KETTEN STONE, *Marmor hammiles*.

Opake, without lustre, compact, consisting of accreted round granulations. Found in stratified mountains in various parts of Britain, particularly at Ketten in Rutlandshire, and at Bath; in Saxony, Brunswick, France, Swisserland, &c. always in large masses, with rarely the remains of animal substances: colour dull grey, brownish or yellowish, with sometimes a mixture of the two first colours; the granulations are easily detached, and in small pieces may be crumbled between the fingers: What is usually called *Bath stone* and *Portland stone* are varieties of this species.

ROUGH MARBLE, *M. granulare*.

Nearly opake, lamellar, shining internally, hardish, spontaneously falling into granulations, not admitting a polish. Found in vast beds or strata in many mountains of Europe, &c. constituting their principal parts, and never containing the vestiges of living bodies. The granulations of different sizes. Colour white, cinereous, black, brown, red, yellowish, or variegated: fracture foliated, often small and fine, always straight. It is used for building, mending roads, burning into lime, and as a flux for iron-stone.

PARIAN and CARRARA MARBLE, *M. micans*.

Diaphanous, white, lamellar, shining internally, hardish, spontaneously falling into finer granulations, receiving a polish. Found in ancient primitive mountains, in vast strata, and with rarely the vestiges of animal bodies, in Finland, Saxony, Sweden, Bonemia, near Carrara, in the islands Paros and Antiparos, and most mountainous countries, and is frequently the material of ancient buildings; sometimes
it

it contains a portion of quartz, so that it effervesces slowly with acids, and strikes fire with steel. When broken it is a little shining, and has a lamellar grained texture.

Parian marble, containing no iron, does not lose its colour by exposure to air and moisture; whereas white calcareous carbonats in general become yellow under the same circumstances, in consequence of the alteration produced on the iron contained in them; on this account, and from the uniform delicacy of its colour, Parian marble is particularly applicable to the purposes of statuary. The Venus de Medicis and that of the Capitol are of this marble.

Carrara marble, in its general history, corresponds very closely with that of Parian marble; but it is even whiter and of a finer grain than that, and appears to have been ultimately preferred by statuaries on this account. The Antinous of the Capitol, and, according to Dolomieu, the Apollo Belvidere, are of Carrara marble. Some parts of the beds of this marble contain a considerable proportion of siliceous particles: a small proportion is found in the analysis of every part; in which it corresponds with the analysis of Parian marble as given above.

Cipolino Marble appears to be a variety of the Parian and Carrara, stratified or veined with greenish mica: and from the supposed resemblance of these veins or bands to the laminæ of an onion, (*cipolla* in Italian,) it has received the name of Cipolino. Saussure describes it as sometimes entirely white, sometimes partly bluish; and of a granular texture.

Pentelic Marble. This is a variety of the Parian and Carrara. Its name is derived from mount Pentelicus, in the neighbourhood of Athens, where it was first quarried.

White granular Marble with black Veins. This marble, which is met with at Carrara, is very commonly used in this country for chimney-pieces and hearths.

The veins are often too irregularly distributed to afford any probable ground of conjecture in themselves respecting their origin; but in many instances a transient view is sufficient to show that they are a connecting medium between numerous and irregularly-disposed fragments of white marble: and, keeping this observation in remembrance, the nature of the distribution of the veins may often be traced by a nearer inspection, where at first sight every thing seemed irregular and confused. It is worthy of remark, that the fragments of this marble are often mutually so indented as to give the vein a serrated appearance; compared, not unaptly, by Mr. Playfair, to the sutures of the human cranium. It has been argued from this appearance, that the mass in which it occurs must at some time or other have been in a soft state, in order to have admitted such a mutual indentation of the fragments: but in many instances the correspondence of the outline of the connected fragments is so exact, and the direction of the outline is at the same time so irregular, as to render it improbable that the fragments were ever separated from each other; since it is difficult to suppose they could have met again so exactly in the same points of contact. In this case we are left to imagine that some force simply divided the mass in various directions without separating the fragments from each other, further at least than to admit the matter of which the vein is composed: yet this conclusion, considering the exceedingly confused appearance of the whole, seems equally difficult of admission. It appears indeed to be one of those phenomena that admit not of satisfactory explanation.

DOLOMITE, *Marmor dolomiæi*.

Effervescing slowly with acids, covering itself with a vitreous coating in the fire. Found in the Tyrolese mountains, with hardly any lustre or transparency, and breaking into convex fragments, does not moulder by exposure

exposure to the atmospheric air. A fragment of this kind of marble in the Oxford Collection contains numerous minute particles of magnetic iron. Some, if thrown into liquid nitre at a red heat, give out a phosphorescent appearance; which, commencing at the edges of the fragment submitted to the experiment, proceeds to the centre: this phosphorescence is little more than momentary, and is not produced by heat; nor indeed by ignited nitre upon a fragment that has previously been exposed to a red heat.

Primitive marbles possessing the foregoing characters are called Dolomites, from M. Dolomieu; who first observed them among the remains of ancient sculpture at Rome; and afterwards in the mountains of the Tyrol, and in the Alps: but this class of marbles has not yet been accurately defined. Many statues of Grecian workmanship are made of Dolomite; of which there are no known quarries in Italy: many of the relics of ancient statuary at Rome are however of Dolomite, and hence these are supposed to have been brought from Greece.

ELASTIC MARBLE, *M. elasticum*.

Elastic, yellowish-white, emitting a phosphorescent light when thrown on red-hot iron. Found on Mount Gothard in Swisserland, in large masses: surface rough and uneven; slightly flexible and evidently elastic when its length exceeds eleven or twelve times its thickness: effervesces and dissolves very slowly with acids.

FILTERING STONE, *M. porosum*.

Perforated with pores, without lustre, opaque, not receiving a polish. The different varieties are found in the quarries of Ruderstorf in Germany; in the Pyrenees, and province of Bearne; near Idria in Carniola; also in Alsace, and the vast mountains of Bohemia. The pores are formed by pyrites formerly imbedded

ded in it, but which has mouldered away and been washed out.

FLORENTINE MARBLE, *M. Florentinum*.

Mixed with argil, opaque, compact, receiving a polish, curiously depicted. Found in Italy and Mount Sinai, yellowish-grey, with generally brown pictured marks of various forms.

TRUE MARBLE, *M. nobile*.

Subopaque, compact, of a splintery fracture, receiving a high polish, and of a fine colour. The true marble forms stratarial mountains in almost every part of the globe, exhibiting innumerable varieties of colour and depiction: it is more or less loaded with petrifications, particularly of the testaceous kind; burns into very good lime, and is chiefly used in sculpture and costly buildings.

COMMON LIMESTONE; *M. vulgatum*.

Subopaque, compact, of a splintery fracture, receiving an indifferent if any polish. Found in vast mountainous masses, sometimes in rounded lumps, as at Aberthaw in Glamorganhire, sometimes on the beach in the form of shingles: colour greyish, bluish, blackish, sometimes cream-colour, flesh-colour, or yellowish, often with several colours mixed. Differs from the marbles only in colour and polish; and is the material every-where used for burning into lime.

SUILLUS, SWINE-STONE.

CONSISTING of carbonat of lime, carbonic acid, sulphurated hydrogen, and water: when scraped or rubbed emits an urinous or garlicky smell: soluble almost entirely in acids, with effervescence; burning into quicklime. There are five species.

COMMON SWINE-STONE, *S. marmoreus*.

Opaque, compact, black, receiving a fine polish,
with

with the fragments more or less convex. Found in the stratified mountains of Sweden, Belgium, Franconia, Bohemia, and Silesia, often abounding in petrified bodies, breaking into indeterminate fragments, and without internal lustre. Bergman says, that in the mountains of West Gothland dark-coloured fetidly-smelling limestone occurs in great plenty, and is there burned to lime; the expense of fuel being much diminished, from the aliment the stone itself affords when heated to redness. Mr. Kirwan adds, that this quality is known in many parts of the county of Galway, where this stone abounds, but fuel is scarce; and hence it is often employed to heat rooms, as it remains hot many hours.

CRYSTALLINE SWINE-STONE, *S. crystallinus*.

Crystallized in elongated six-sided pyramids; some specimens have the crystals diverging, others the crystals spherically clustered. This species is found under the common soil in Sweden, Westrogoth, and Oeland.

TREMOLITES, TREMOLITE.

CONSISTING of carbonat of lime, a larger proportion of silice, a little carbonat of magnesia, water, and carbonic acid gas: radiate, hardish, shining, brittle, emitting a phosphorescent light in the dark when struck or rubbed: partly soluble in nitric acid, with effervescence.

There is but one species, called *Tr. Hoepfneri*; discovered in Mount Tremola, near St. Gothard, in Switzerland. Colour white, reddish, greenish, yellowish, or greyish; sometimes amorphous, sometimes in crystals, the crystals longitudinally striate.

STELLARIS, STARRY EARTH.

CONSISTING of carbonat of lime, a smaller proportion of silice, and a little water and oxyd of iron: fibrous in a stellate manner, of a silky lustre, soft, parasitical:

rafitical: easily melting in the fire, with ebullition: partly soluble in nitric acid, with effervescence.

There is but one species, named from the place of its growth, *St. Transylvanica*. It is found near Untershebeck in Transylvania, in the harder kind of Marmor micans, white or sea-green. Gmelin suspects it may be a Zeolite.

HUMUS, MOULD.

CONSISTING of carbonat of lime, with a small proportion of fix'd hydrogen and carbonic acid gas, and oxyd of iron: formed by the decayed remains of animal and vegetable substances: light, friable, imbibing but not retaining water; meagre, rough, humid, of a dull colour: effervescing with nitric acid, becoming cinereous in a smaller heat, in a stronger running into a frothy kind of glass.

ANIMAL MOULD, *Humus animalis*.

Impalpable, greedily imbibing water, hardly effervescing with nitric acid in its rude state, but sensibly so when burnt. This is the species found in churchyards and other places abounding with putrid animal matter; white or cinereous, very light and fertile.

VEGETABLE MOULD, *H. dactylea*.

Brown, in a very subtle dust. Found in all inhabited places, principally originating from animal manure and depositions, so very fine as when mixed with water to pass through a coarse cloth or filtering paper: it affords the best and richest garden-mould.

HEATH MOULD, *H. pauperata*.

Soon parting with its moisture, and when dry becoming farinaceous. Found on heaths, and produces a poor soil; because its particles are so minute and impalpable, as in dry seasons to be blown about by the least breath of wind.

SPONGY MOULD, *H. effervescens*.

Swelling after having absorbed and retained water some time. Common in spongy places, and may probably have its origin in the rotten roots of plants: it takes a long time in drying, and is a bad soil for the farmer or gardener, because in the spring season it intumesces by the frost at night, and the heat by day, and lifts up and eradicates the smaller plants.

BOG MOULD, *H. lutum*.

Very light, not combustible, black when moist. Found in swamps and marshes under water, and is produced by the gradual corruption of bog-plants: it is so light as to remain some time suspended in water, and is serviceable in sandy soils.

IRON MOULD, *H. martialis*.

With a metallic tinge. Found in various parts of Britain, Sweden, Germany, Syria, &c. in swamps and marshes, yellow-brown, reddish, purplish, or black, which colour it receives from its contamination with oxyd of iron.

HOLY MOULD, *H. muriatica*.

Brown, of a saltish taste. Found in the deserts on the confines of the Red-sea, Egypt, and Syria.

MARGA, MARL.

CONSISTING of carbonat of lime and argil, with generally some oxyd of iron: soft, opaque, of a common form, internally earthy, light and miscible with common water by agitation, found in stratified mountains: partly soluble in nitric acid, with effervescence: hardening in the fire, and vitrifying in a strong heat.

COMMON MARL *Marga terrea*.

Friable, meagre, a little rough to the touch.

If

If calcareous carbonats contain a sufficient proportion of clay to crumble by exposure to air, and fall into a powder in water, they are then called Marls. The proportion of calcareous carbonat in marls varies from about two thirds to four fifths; all which part may be separated by most of the acids; being readily soluble in them: the residuum is clay; which itself consists, as all clays do, of alumine and silex. The several constituent parts of marl are in such a minute state of division as to be invisible to the naked eye.

According to the proportion of the calcareous and argillaceous parts, different marls, as used in agriculture, are applicable to different soils; where the calcareous part is comparatively abundant, the marl is proportionably applicable to a clayey soil; where the argillaceous part is more considerable than usual, to a sandy soil.

There is a variety of schistose marl impregnated with bitumen, remarkable for commonly containing the impression of fish or marine plants: and it is further remarkable in this marl, that the positions of the fish are often very much contorted; as if they had died by a violent death. Emmerling indeed goes so far as to suppose that the copper pyrites, often found in marl of this kind, was the occasion of their death, their substance itself being impregnated with the pyritical matter. Saussure mentions a curious fact respecting the impressions of fish met with on a hard schistose marl in Monte Bolca, near Verona: namely, that the impressions of one hundred and five different species have been there recognized, of which

Twenty-seven belong to European seas.

Thirty-nine - - - Asiatic seas.

Three - - - African seas.

Eighteen - - - South American seas.

Eleven - - - North American seas.

Seven - - - Fresh-water lakes and
rivers of different parts of the world.

From

From the fissile structure of marls, the frequent presence of organic remains in them, and the equable mixture of their component parts, Wallerius supposes that they originated from the detritus of other substances; and that they were once in a liquid state. This is now very generally allowed to have been their origin: especially as they only occur among secondary strata.

It appears from Pliny, and the *Rei Rusticæ Scriptores*, that marls were very anciently used as manures. The principle of their use is not yet clearly understood: but seems to depend partly on the minute state of division in which the calcareous part exists; for Wallerius relates, that in some countries, finely divided calcareous carbonats are used simply as a substitute for marl. A similar practice prevails in some parts of England; and the substance employed is a kind of fine sand, consisting almost entirely of minute and minutely comminuted shells, met with in Scilly islands, and some parts of the coast of Cornwall.

The common marl, *Marga terrea*, found in almost every country in Europe, in strata. Colour whitish, yellowish-white, or yellowish-grey, and grows paler in drying: sometimes found mixed with Mica gypsum or sand, in the latter case it is fusible into a transparent glass, sometimes impregnated with iron, very rarely with other metals: generally contains from 60 to 80 per cent. of mild carbonat of lime, the remainder of alumina or clay: specific gravity, from 1.6 to 2.4.

NILOTIC MARL, *M. Nilotica*.

Farinaceous, brownish, cinereous when burnt, mixed with mould. Found in the plains of Egypt annually overflowed by the waters of the Nile, where it is left by deposition after their recess, and is highly fertile.

BITUMINOUS MARL, *M. bituminosa*.

Indurated, not crumbling in the air, black, a little greasy,

greasy, shining a little within, of a slaty texture, breaking into discoid fragments. Found in stratified mountains of various parts of Germany, frequently containing the impression of fish and marine plants, and frequently the ores or oxydes of copper: colour greyish, bluish, or brownish-black, according to the quantity of bitumen it contains, which renders it more or less inflammable: has a greasy and somewhat glittering appearance, and a slaty texture: the thin plates are a little sonorous: burns before the blow-pipe with a black dross.

LIMESTONE MARL, *M. anonyma*.

Shining within, hardish, of a dull iron colour. Found near St. Amboix in France, sometimes so hard as to admit a polish and strike fire with steel: besides a little schistose earth, sulphur, and quartz, it contains iron $\frac{1}{33}$, argil $\frac{2}{33}$, carbonat of lime $\frac{92}{100}$.

MAGNESIATA, MAGNESIA.

CONSISTING of carbonat of lime, a little black oxyd of manganese, carbonic acid gas, and water: hardish, lamellar, spontaneously separating into grains: gradually changing the colour of its surface when exposed to the air, effervescing slowly with acids, and often not without trituration; becoming black in the fire. Professor Kidd observes, that magnesia has not yet been met with in a native state. Its natural compounds are principally mixtures, or chemical combinations, of different earths with oxyd of iron; and, generally speaking, are remarkable for an almost unctuous softness, perceptible upon touching them; and for their disposition to a fibrous texture, and green colour. But though these characters evidently depend upon the presence of magnesia, the proportion of this earth rarely amounts to so much as one half of the weight of the mineral in which it is contained. Of the other component parts flint is the most abundant, and frequently amounts to as much as all the rest.

COMMON

COMMON MAGNESIA, OR BROWN SPAR, *Magnesia granularis*.

Subopaque, tranquil in the fire, breaking into indeterminate fragments of a common form. Found in various parts of Germany, Sweden, France, &c. in large masses: colour white, flesh and rose-colour, greyish, yellowish, and reddish-white, with frequently an iridescent metallic appearance: generally opaque, and becomes brownish when exposed some time to the air. Contains carbonat of lime 50, oxyd of iron 22, oxyd of manganese 28.

SPARRY MAGNESIA, *M. spatiosa*.

A little shining internally, making a grey mark, breaking into rhomboidal fragments, with the foliations straight. There are many varieties of this species, which are found in the mines of Hercynia and Saxony, diaphanous, subopaque, rarely opaque: colour cinereous, reddish or yellowish-white, isabella, rosy, flesh colour or brownish-red, yellowish or blackish brown, with sometimes several of the colours blended together, and often with a metallic lustre: differs from the *Ferrum spatiosum* by the smaller proportion of iron and oxyd of manganese it contains.

PICROSPATUM, BITTER SPATH.

CONSISTING of carbonat of lime, a nearly equal quantity of carbonat of magnesia, and a very little of the oxyds of manganese and iron: parasitical, hardish: effervescing slowly with acids.

Picrospatum amarum, a single species, of which there are three varieties.

1. In an earthy form. Found near Thionville, of an olive colour, consisting of a large proportion of mild carbonat of lime, and a smaller of carbonat of magnesia, but no alumina.

2. In a stony form and amorphous. Found near

3 A 2

Creutzenwauld,

Creutzenwauld, whitish; contains carbonat of lime 75, carbonat of magnesia 12, iron 13.

3. Crytallized. Found in Germany and Sweden, greyish-white: the crytals are in a six-sided prism, transparent or pellucid, with a rough surface. Contains carbonat of lime 52, carbonat of magnesia 25, iron and manganese 3.

GYPSUM, GYPSUM.

CONSISTING of carbonat of lime united to sulphuric acid: light, very soft, a little frigid: not commonly effervescing with nitric acid, melting with difficulty in the fire, but easily crumbling to powder, which causes no ebullition in water, but forms a paste hardening and distending by exposure to the air.

Plaster of Paris is prepared from gypsum by calcination: which process drives off the water of the sulphat of lime, and the carbonic acid or fixed air of the carbonat of lime, contained originally in the gypsum. The gypsum in this state has a strong disposition to absorb a certain proportion of water; and during this absorption the mass is consolidated: in which process it is supposed that the particles of the calcined carbonat of lime act as a connecting medium round which the sulphat of lime, in re-combining with the water that had been driven off during the calcination, undergoes a hasty and imperfect crytallization.

The silver medal of the Society of Arts having been given, in 1805, for extensive and successful experiments of this valuable article, as a *new manure*, for clover, and all the varieties of grasses on dry lands, we lay before the public an extract of a letter received from a respectable gentleman in New York, dated the 4th of March 1807, on this interesting subject, which we earnestly recommend to the notice of the agricultural interests of this nation, as the spring and summer seasons are best adapted for the use of this article, so valuable in effect, so cheap in price, and so plentifully

plentifully dispersed through some parts of this kingdom, as to ensure an inexhaustible supply.—“Several of our experimental farmers have assured me, that lands which have been for twenty years manured with gypsum are not impoverished by the use of it. About fifty miles up the Hudson’s River from this city, and from thence to the northward, it is in general use, and not less so in New Jersey and Pennsylvania: its effects are wonderful, particularly on grass. The crops of corn and Indian corn have been more than doubled by the use of gypsum instead of stable manure. It is found to answer best on dry, gravelly, or sandy, soils. Remote from the sea, it often succeeds on any soil; near the sea, it has an effect on some grounds, and not on others, where there is not any great difference in the soil. It is impossible to give you any estimate of the quantity of gypsum or plaster brought here from Nova Scotia. It comes free of duty, and the vessels which bring it have generally fish and other articles. There are probably from 7 to 10,000 tons of British (Nova Scotia and New Brunswick) shipping employed in this trade, who, upon an average, make four trips each season; and all these carry more than their registered tonnage, I may safely say more than 40,000 tons are brought here. Of this, however, much is exported again to the southward.”

That the ancients were accustomed to clarify their wine with gypsum is proved by different passages of the Greek writers on husbandry. They threw gypsum into their new wine; stirred it often round, then let it stand for some time, and, when it had settled, poured off the clear liquor. It would however appear, that they had remarked that gypsum caused the spirituous part to evaporate; for we read that the wine acquired by it a certain sharpness which it afterwards lost, but that the good effects of the gypsum were lasting. This process in modern times has been publicly forbidden in many countries, as in Spain in the year 1348. Few kinds

kinds of gypsum are completely saturated with the vitriolic acid; and at any rate we have no reason to suppose that the ancients sought perfect gypsum for their wines. This method is not yet disused. We are told by Arvieux, that it is still employed in the island of Milo; and we shall here take occasion to observe, that salt water also is added to wine there, even at present. Christopher Vega reproaches the Spaniards with the use of gypsum; and it has been condemned by the modern as well as the ancient physicians, such as Cartheuser. Our countryman, James Hardy, seems to suspect that gypsum contains lead and arsenical earth; but it appears that this writer doubted whether our gypsum be the same as that of the ancients; and indeed it is necessary, before we use their information respecting natural objects, to examine carefully whether they understood by any name what we understand by it; and what they meant by gypsum has been determined neither by Stephanus, Ferber, nor Gesner. There is a passage in Theophrastus in which a ship is said to have been set on fire in consequence of the moistening of its cargo, which consisted of gypsum and wearing apparel: in this case there can be little doubt that the substance called *gypsum* could not have been of the same nature with the gypsum of the present day; which in no instance perhaps contains such a proportion of carbonat of lime as when calcined would be sufficient to produce this effect.

EARTHY GYPSUM, *G. terreum*.

Powdery, of a white colour. Found in the fissures of gypseous rocks in Saxony, in the form of a white friable loose powdery substance, and seems to originate from crystallized selenite, and will not concrete without being wetted: feels dry and meagre, hardly sinks in water, is not gritty between the teeth; when heated below redness, it becomes of a dazzling white: has no lustre or transparency.

SANDY

SANDY GYPSUM, *G. arenaceum*.

Consisting of white distinct subdiaphanous granulations. Found in Thuringia, and originates from alabaster which has crumbled to powder: it resembles the last, except that its particles are larger, like unto small grains of sand, and are very gritty between the teeth.

ALABASTER GYPSUM, *G. alabastrum*.

Compact, dry, and meagre; a little shining, breaking into indeterminate fragments, of a common form, receiving a polish. Found in Derbyshire, Persia, and various parts of Russia, Spain, Tuscany, Sicily, and other places, in stratified mountains. Colour various, sometimes spotted, intersected with veins, and depicted with various colours: does not effervesce with acids, when pure, is softer than marble, and does not take a good polish: texture shivery and glittering. Contains carbonat of lime 32, sulphuric acid 30, water 38.

FIBROUS GYPSUM, *G. fibrosum*.

Meagre and dry, brittle, breaking into long splintery fragments. It is found in various parts of Britain and Europe; and, according to Mr. Sowerby, is formed by the decomposition of sulphur of iron or pyrites, the sulphur of which, combining with oxygen forms sulphuric acid, which coming in contact with lime, forms this gypsum in various fanciful modes: its texture is fibrous, filamentous, or radiate, flexuous or straight, parallel or scattered, colour white, grey, yellowish, red, or honey-colour, with the colours sometimes meeting in stripes.

COMMON GYPSUM, *G. usuale*.

Meagre and dry, lamellar, with the foliations generally spherical: breaking into indeterminate fragments.
Found

Found in Britain and various parts of Europe, in vast masses, and sometimes in lenticular crystals: colour yellowish or blackish-grey, cinereous, ochraceous, flesh-colour, rarely honey-colour: breaks into fine and coarse-grained concretions, sometimes cohering so loosely as to be easily triturated between the fingers.

SELENITES, *G. selenites*.

Pellucid, shining, rhombic, lamellar with straight parallel foliations, breaking into rhomboidal fragments. Found in Germany and Spain, with the crystals generally in six-sided prisms, terminated by two-sided or four-sided summits: it commonly causes double refraction: colour white or grey.

HEPATICUS, HEPATIC EARTH.

CONSISTING of carbonat of lime, baryt, sulphuric acid, and inflammable matter: soft, lamellar; either spontaneously or when rubbed giving out an odour like liver of sulphur, not effervescing with acids: crumbling to powder in a small degree of heat, which forms a paste with water, and hardens in the air. There are three species, *solidus*, *squamosus*, and *spatosus*.

FLUOR, FLUOR.

CONSISTING of carbonat of lime and fluoric acid: somewhat ponderous, parasitical, never hard, shining in the dark, and crackling when heated to the degree of boiling water: not effervescing with acids, but, if distilled with the mineral acids, emitting the fluoric acid gas, which has the property of dissolving glass: melting before the blow-pipe into a transparent glass.

EARTHY FLUOR, *Fl. pulverulentus*.

Whitish, without lustre, powdery, with the larger particles not cohering. Found at Kabola Poiana in the district of Marmaros, in Hungary, between two beds of quartz: colour light grey, greenish-white, or bluish-

bluish-green: when strewed on an iron plate heated a little below redness, it diffuses a blue or pale yellow phosphorescent light: feels harsh, and stains a little: contains lime 21, alumina 15, silica 31, fluoric acid 28, phosphoric acid 1, muriatic acid 1, oxyd of iron 1, water 1.

COMPACT FLUOR, *Fl. compactus*.

Hardish, compact, of an even texture, diaphanous, brittle, breaking into indeterminate fragments. Found in Britain, and near Stolberg and Strasburg, whitish-grey, more or less passing into green, often spotted: fracture even or conchoidal.

SPARRY FLUOR, *Fl. spatofus*.

Hardish, shining, brittle, of a common form, breaking into pyramidal fragments, lamellar. Found in Britain, Norway, Sweden, Spain, and Germany. White smoke-colour, green, violet, purple, rosy, honey-colour, or varied with spots, blotches, or veins, semipellucid or transparent, breaking into three, rarely four, sided fragments. Takes a fine polish, and is manufactured into various vases and figures: contains carbonat of lime 75, fluoric acid 16, water 27.

CUBIC FLUOR, or DERBYSHIRE SPAR, *Fl. cubicus*.

Hardish, shining, smooth, lamellar, brittle, breaking into pyramidal fragments, cubic, of various forms. Found in Derbyshire and Northumberland, Spain, France, Saxony, Germany, &c. of the same variety in colours as *Fl. spatofus*; most frequently pellucid, rarely opaque. The crystals solid or hollow, or containing a small drop of water or some fossil, and placed in a decussate manner, laterally, or irregular, or aggregate in a kidney or imperfect globular form.

Fluor, or fluat of lime, is rarely of an earthy texture: it is most frequently crystallized in cubes, as in this species, and is remarkable for the natural beauty

and variety of its colours; whence fluors have been occasionally called mock gems. The primitive form of fluat of lime is easily obtained by mechanical division; but does not often occur in nature. It is found principally in veins, either simple or mixed; and accompanies various metallic ores.

There is a specimen in the Oxford Collection, the form of which is that of a bivalve shell; to the inner surface of which are attached imperfect crystals of nearly colourless fluor. This specimen had been classed as a carbonat of lime, from which substance it is scarcely distinguishable by the naked eye.

Many of the crystals of Derbyshire fluor are colourless, and have their surfaces sprinkled over with minute particles of pyrites. In some instances it appears, that after these pyritical particles have been deposited, an augmentation of the crystal of fluor has taken place: so that the spangled surface of the inner crystal may be viewed through the superincumbent laminæ of the outer. In a few instances this process has been repeated several times; and, by means of the interposed particles of pyrites, numerous parallel planes may be seen within the body of the crystal.

The *blue fluor* of Derbyshire is found in a mine near Castleton. The mine is in a hill of limestone, the substance of which is broken into irregular cavities. Some of these cavities contain large stalactitic concretions of carbonat of lime: many are partially occupied by masses of brown clay, in which irregularly shaped nodules of blue fluor are met with. A transverse section of these nodules exhibits a concentrically crystalline structure. This is the variety that is most commonly employed in the fabrication of ornamental vases, &c. The natural colours may be modified or destroyed by heat; passing from blue to reddish purple, brown, and different shades of yellow; in the last change having often a honey-combed appearance: but the colours thus artificially obtained never equal the natural colours in beauty.

APATITES,

APATITES, APATITE.

CONSISTING of carbonat of lime and phosphoric acid: brittle, hardish: soluble in nitric acid; melting in the fire with difficulty, but, when powdered and thrown upon burning coals, emitting a yellowish-green phosphorescent light. The name *Apatite* has been given to this genus in consequence of the errors mineralogists were led into respecting its real nature, from its resemblance to the Emerald, Chrysolite, Hyacinth, and other gems. It is also called] *Spargelstein*, or Asparagus-stone; from the particular shade of green of some of its varieties. In hardness it is inferior to fluor spar. Its proper name is *crystallized phosphat of lime*; but the primitive form occurs very rarely. The prism is frequently so compressed as to become tabular; and its sides are generally longitudinally striated. Crystallized phosphat of lime may be distinguished from those precious stones with which it is likely to be confounded, by its phosphorescence and inferior degree of hardness. There are seven species, of which we need only describe

COMMON APATITE, *A. prismaticus*.

Appears in six-sided prisms, of a rather greasy lustre, parafitcal, breaking into indeterminate fragments, of a minutely granular texture, which when broken transversely is lamellar. Found in Cornwall, Saxony, and Germany, with tin ore and fluor: colour green, pale violet, reddish, or white, rarely yellowish, cinereous, blue, or olive, colour: loses its colour and transparency in the fire, but melts with great difficulty: is very finely striate longitudinally: crystals small, solitary or irregularly cohering; the prisms sometimes perfect, sometimes terminated at one or both ends with a six-sided pyramid; the lateral margins sometimes ending in a point, and the terminal ones with the angles truncate, sometimes the lateral margins are rounded.

BORACITES, BORACITE.

CONSISTING of carbonat of lime, a larger proportion of carbonat of magnesia, the greater part boracic acid, and a little alumine, filex, and oxyd of iron: hard, lamellar, lightish, cubic: becoming electric by heat, not effervescing with acids, crackling in the fire, and before the blow-pipe contracting, and melting into a yellowish glass. There is but one species, called

CUBIC BORACITE, *B. cubicus*.

Found at Kalkberg near Luneburg, seated in a bed of gypsum. Colour hyaline or greyish-white; sometimes passing into violet or sea-green: cubes very small, with truncated edges and angles, so that the faces of the truncated angles exhibit alternately hexagons and triangles: fracture compact, flat, conchoidal. Contains boracic acid 68, carbonat of magnesia 13, carbonat of lime 11, filex 1, argil 1, iron 6.

ORDER IV. ARGILLACEOUS EARTHS.

ALUMINARIS, ALUMINE.

CONSISTING almost entirely of alumine: meagre to the touch, light, without lustre, earthy, adhering a little to the tongue, staining a little; nearly soluble in nitric acid, contracting and hardening in the fire, emitting sparks before the blow-pipe.

Native Alumine, the only species, is said to be found in various parts of Britain, Muscovy, and Saxony, in kidney form masses: snow-white, very soft, breaking into indeterminate fragments, and does not readily diffuse itself in water.

This earth is a constituent part of the salt called *Alum*; from a solution of which it may be conveniently obtained, nearly in a state of purity; and hence its present name. It is also a principal constituent part of clays, or natural argillaceous compounds.

Dr.

Dr. Kidd, professor of chemistry at Oxford, observes that the existence of native alumine is nearly as questionable as of native lime. An earthy substance said to be native alumine, and often met with in cabinets in small kidney-formed nodules of a very white colour, was some years since discovered near Halle in Saxony; but as it was found, according to common report, in a piece of ground attached to a chemical laboratory, many mineralogists doubted its natural origin; and supposed it to be an artificial preparation, which had been thrown aside after the completion of the experiments that had given rise to its production. Mr. Jameson however says, that from its form, and the situation where it is found, it appears to have had a natural origin: and that no laboratory is nearer the spot than a quarter of a league. Yet, from the analysis he gives of it, it might be inferred that this substance is not a natural production: and Dr. Kidd concludes that it is not entitled to be considered as a specimen of native alumine.

ARGILLA, CLAY.

CONSISTING of alumine and silex, with generally some oxyd of iron and inflammable matter: opaque, without lustre, of a common form, soft to the touch; earthy, lightish, soft, imbibing and retaining water and oil, by each of which it is softened, and rendered plastic by the former, and emitting an earthy smell: not effervescing with nitric acid; contracting and becoming harder in the fire. There are thirty species.

PORCELAIN CLAY, *Argilla porcellana*.

Meagre, white, friable, adhering to the tongue, becoming white when burnt, and in a very strong heat forming porcelain: Found in Cornwall, Japan, China, Saxony, and various parts of Europe, and is supposed to originate from decomposed felspar. Colour

lour white, greyish, reddish, or yellowish-white: adheres very slightly to the tongue, and feels soft, but not greasy: does not change its colour when exposed to heat, but becomes white, and transparent in proportion to the quantity of fîlex it contains: it is principally used in the manufacture of china ware: contains alumine 60, fîlex 20, air and water 12. The clay of which the Berlin porcelain is made, is found below Halle, in the district of Magdeburg: that, of which the Austrian porcelain is made, at Passau. The French porcelain clay is met with in the vicinity of Limoges.

If clay, which otherwise would be fit for making porcelain, contain one tenth part of lime, it is fusible in the heat to which the porcelain must necessarily be exposed, and consequently unfit for the purpose intended. It may contain as much as one twentieth part without occasioning the vitrification of the mass. Oxyd of iron is injurious in a double sense; for it not only promotes vitrification, but discolours the porcelain by the alteration it undergoes during the process of baking. An inferior kind of porcelain clay is found in that part of Bovey heath, in Devonshire, which is near the London road: it is met with not much below the surface of the earth; and, from a consideration of its situation and the attendant circumstances, appears evidently to be a natural deposition of earthy feldspar. Whoever considers the swampy nature of that heath, the appearances observable on its surface, and its relative situation to the adjoining granite-hills, may easily be convinced that it is derived from the detritus of these, washed down and deposited by water; for this heath is as it were a natural basin, which must necessarily receive whatever is brought down from the adjoining high ground; and its surface in a great measure consists of a white sandy quartz and occasional crystals and fragments of feldspar, that evidently correspond with the quartz and unaltered feldspar of the neighbouring granite.

PIPE CLAY, *A. leucargilla*.

Very soft and greasy to the touch, adhering to the tongue, shining when rubbed, becoming first blackish and paler when burnt, apyrons. Found in Normandy, near Cologne, Livonia, and other parts of the world. Colour varying from pure white to black, and is often variegated; when first exposed to heat, it becomes blackish, from the inflammable matter it often contains; but by continued heat it turns pure white: it is used for tobacco-pipes and various vessels. As to its constituent parts it scarcely differs from porcelain clay; but the siliceous particles are not sufficiently fine to render it applicable to the same purpose.

POTTERS CLAY, *A. lithomarga*.

Potters clay does not differ materially from pipe-clay. It frequently contains a greater proportion of lime and of oxyd of iron; and hence is more liable to vitrify, and to be discoloured by the application of the higher degrees of heat; on which account it is employed in the composition of the inferior kinds of earthen ware or pottery; and is called, in consequence, potters clay.

The situation in which potters clay is found, and its general appearance and character, afford probable grounds for supposing that it has been formed, in the manner described in the preceding pages, by the deposition of the finer parts of disintegrated rocks of various kinds. Those which contain least iron have been probably derived from granite and its varieties: those which contain most, from basalt perhaps, and rocks of that genus.

FULLERS EARTH, *A. fullonica*.

Fullers earth, which is commonly of a dark drab colour with an obscure shade of green, is not ductile, like common clay, when mixed with water; but rather

rather crumbles into a powder like marl. It is also nearly friable; and does not adhere to the tongue. The fullers earth of the island of Cimolus, analysed by M. Klaproth, was brought over from thence by Mr. Hawkins. Similar specimens were also brought from a neighbouring island; and in both instances numerous grains of quartz were diffeminated through the mass. Fullers earth is met with in France, Saxony, and Sweden; and in very great abundance in different parts of England, as at Woburn, Ryegate, and Maidstone. A great proportion of the fullers earth of commerce comes from Hampshire.

The specific action of fullers earth depends on the alumine contained in it: and it appears that the proportion of this should not be less than a fourth or fifth of the whole mass. It should not however be much more; for in that case the fullers earth would be too tenacious to diffuse itself through water. The flex also should be in a very minute state of division; otherwise the particles, being too rough, would wear out the texture of the cloth to which it was applied. M. Klaproth found that the earth from Cimolus possessed the fulling property in a superior degree to the English.

LEMNIAN EARTH, *A. Lemnia*.

Specific character, greasy, shining by friction, adhering a little to the tongue, very soft, lightish, of a conchoidal texture. Found principally in the Isle of Lemnos, and in Silesia; generally dull isabella, yellow or pale liver-colour, rarely diluted flesh-colour, with sometimes black spots or shrub-like ramifications: surface smooth and polished like agate; fracture conchoidal; with angular fragments.

The Lemnian earth affords a considerable revenue to the Turkish government: the native ochre of Lemnos is washed, in order to separate the sand, &c. and is then formed into flat cylindrical pieces; which are stamped

stamped, and sold under the name of *terra sigillata*. These were formerly used, to a great extent, medicinally: but their use is now principally confined to painting.

COMMON BRICK-CLAY, *A. communis*.

Specific character, very soft, greasy, adhering to the tongue, plastic, staining the fingers a little: of an earthy texture; growing red in the fire, and before the blow-pipe melting into a greenish glass. The usual colour of this clay, which is met with in great abundance in various parts of England, is brown or slightly reddish-brown; and depends upon the presence of oxyd of iron. The red colour peculiar to common bricks and tiles depends upon the alteration of the oxyd of iron during the process of burning; and this probably is effected by the decomposition of the water, with which the clay was tempered to give it the requisite degree of tenacity; its oxygen contributing to the farther oxydation of the iron, and consequently producing the usual change of colour. If the proportion of oxyd of iron contained in brick-clay be greater than ordinary, and especially if at the same time the proportion of lime is also considerable, the bricks are often superficially vitrified: and this affords an explanation of an appearance very common in brick-kilns, where the surfaces of some of the bricks are glazed, and of a green colour; the oxyd of iron being disposed to vitrify with earthy substances, particularly lime, and possessing the property of communicating a green colour to glass. A variation in the proportions of lime and oxyd of iron is thus seen to affect the chemical characters of bricks. Their mechanical characters are also affected by a variation in the proportions of the silex and alumine: if the silex predominates in too great a degree, the clay is not sufficiently ductile; if the alumine, the bricks made from it will be rify. The best propor-

tions are, *filex* 86, *alumine* 14. These proportions are very nearly the same as in the clay of the neighbourhood of London: and, where the proportion of *alumine* predominates to this extent, the compound is called *loam*.

Stourbridge Clay is a natural clay containing very little lime or iron; and hence it is neither much coloured nor disposed to vitrify in the higher degrees of heat: on which account it is employed in the construction of furnaces: and in the fabrication of *fire-bricks*, as they are called, from being so refractory; and of those coarse vessels in which porcelain is usually baked, in order to preserve it from external injury during that process. Those fire-bricks which are made at Stourbridge very readily produce sparks when struck by steel; and their internal appearance is altogether not very unlike the soft white granite of Cornwall, excepting that they are of a yellow colour. The granite of Cornwall is sometimes indeed employed as a clay in the fabrication of crucibles, a manufactory of which kind is carried on at Truro. From an examination of the substance of these crucibles it appears, that the granite has been simply pounded; and tempered with just a sufficient proportion of clay to give it the requisite degree of tenacity: since the constituent parts of the granite may be easily recognized by the eye. These crucibles are nearly if not quite as refractory in the fire as the Hessian crucibles: the Truro crucibles probably do not contain so great a proportion of oxyd of iron.

BOLE, Argilla bolus.

Greasy, shining by friction, dissolving in the mouth, crumbling into powder immediately in water, growing reddish and easily dissolving in the fire, of a conchoidal texture. Found in Armenia, Italy, France, Portugal, and Germany, and is frequently produced from decayed lavas: colour generally dull red or brown,

brown, sometimes yellow, flesh-colour, cinereous, and in innumerable varieties. Near Idria in Carniola, it is found mixed with cinnabar; and near Kafnick in Hungary, combined with silver.

RED OCHRE, *A. rubrica*.

Soft, staining, adhering to the tongue, red, brittle, does not become ductile in water, of an earthy texture. The term *ochre* in its original acceptation implied a yellow earth: for Theophrastus, having already called it an earth, says that it is used instead of arsenic; and Pliny says of arsenic, that it is most valuable when of a pure golden colour. Numerous passages might be produced, were it necessary, to prove this point. The term is at present applicable to any coloured earth; but particularly to natural clays coloured by oxyd of iron. The principal varieties are yellow, red, and brown. The red is found in Siberia, Dalecarlia, Bohemia, Portugal, and France, generally among iron ore, with which it commonly abounds. Colour dark red, or intermediate between brick and blood-red. Fracture earthy, sometimes conchoidal: feels rough, assumes a polish from the nail, strongly stains the fingers, adheres to the tongue, falls immediately to powder in water, does not effervesce nor easily dissolve in acids, crackles and grows black when heated to redness, and melts at last into a dark greenish-yellow frothy enamel.

YELLOW OCHRE, *A. lutea*.

Very soft, staining the fingers, and adhering to the tongue. Found near Wehrau: feels smooth or somewhat greasy: fracture earthy, or inclining to the conchoidal: adheres strongly to the tongue, takes a high polish from the nail, and strongly stains the fingers: falls immediately to pieces in water, with some hissing, afterwards to powder, but does not diffuse itself through it: does not effervesce with acids, or easily

dissolve in them: heated to redness it crackles, hardens, acquires a red colour, and gives a reddish streak, and melts at last into a liver-brown porcelain mass: contains alumine 50, oxyd of iron 40, water acidulated by sulphuric acid 10. This substance is principally made use of as a coarse paint. A variety met with in Shotover-hill, near Oxford, is of a remarkably uniform colour and fine texture; it is preferred in commerce to all others. Coarse yellow ochre is frequently converted into red ochre by calcination; in which process probably the carbonic acid or fixed air is driven off, and the iron at the same time is further oxydated by means of the decomposition of the moisture contained originally in the ochre. Theophrastus says that the method of conducting the process was accidentally discovered by a person, who, in an inn which had been burnt down, saw a heap of ochre that had been partly changed to a red colour by the action of the fire.

TRIPOLI, *A. Tripolitana.*

This substance was originally so called from the town of the same name in Barbary, from whence it was commonly imported: but the name has been extended to similar substances in different parts of the world. The opinions respecting its nature are various; some supposing it to have arisen from the decomposition of porphyry or jasper; others, from basaltic rocks. Saussure conjectures that it is a very fine sand washed and deposited by water; and Wallerius describes it as a kind of fine sand-stone. Any siliceous substance reduced to a sufficiently minute state of division may be used instead of, and hence is often called, tripoli: this is the case with the rotten stone of Derbyshire. It is sometimes imitated by calcining and reducing to powder certain varieties of slate.

The specific characters, as given by Gmelin, are
harsh

harsh and dry, soft, lightish, adhering to the tongue, melting with difficulty, when rubbed with metal assuming a metallic splendour. Found in the Island of Tannia in the South Seas, in the kingdom of Tunis, in Naples, at the river Uda in Russia, Sweden, Flanders, Bohemia, Austria, and various parts of Germany, in stratified mountains, and not unfrequently mixed with sulphur: colour whitish, yellowish-grey, cream and ochre-yellow: is found solid, has a dull earthy appearance when broken, and breaks into indeterminate obtuse regular pieces, is soft and sandy between the teeth, and absorbs water with a noise: does not stain the fingers, and frequently reddens when heated. Contains filix 60, alumine 7, iron 3.

UMBER, OR BROWN OCHRE, *A. umbra*.

Penetrated with bitumen, brown, making a mark, growing reddish when burnt. Found in Britain, Umbra in Italy, in Germany, &c. and is used by painters: colour brown or blackish, adheres to the tongue, and moderately stains the fingers: consists principally of particles of decayed wood mixed with bitumen.

PUTEOLANA, POZZOLANA, &c.

CONSISTING of alumine, filix, and iron, with generally some carbonat of lime: friable; mixed up with water and quicklime becoming so hard as not to be penetrated by water; easily melting in the fire into a black scoria.

GENUINE POZZOLANA, *P. genuina*.

Of a dull colour, tinged, readily obeying the magnet. Pozzolana, so called from Pozzuolo, the ancient Puteoli, is not a disintegrated lava, as some have supposed; but a species of argillaceous earth or stone that has probably been calcined or baked, and then ejected from the volcano. According to Winkleman, it is sometimes of a black, and sometimes of a red, colour: the black pozzolana, which is the heaviest and contains most iron, is used for constructions under water

at

at the present day, as it was in Pliny's time. Neither the black nor the red pozzolana are found in any other parts of Italy than the neighbourhood of Rome and Naples.

VOLCANIC ASHES, *Puteolana cineres*.

Colour and form of ashes. Found in the neighbourhood of most volcanic mountains, from which they are ejected with vast force, and often to a great height and distance, frequently covering vast surfaces, and sometimes burying whole cities: they are sometimes so subtle as to fill up the minutest crevices: colour brownish or reddish-grey. They effervesce slightly with acids, have frequently a magnetic power, and usually contain about half their weight of clay, a small proportion of calx, magnesia, and iron; the remainder is filex.

VOLCANIC SAND, *P. arenacea*.

Cinereous, but consisting of distinct granulations. Found in the neighbourhood of volcanos; composed of small hard grains varying in size; they readily sink in water, and are usually mixed with small fragments of felspar, lava, magnetic iron-stone, &c. they often cover a great extent of ground, sometimes to the extent of fifty leagues around the volcano, and several feet thick.

CÆMENTUM, TRASS or TERRAS.

CONSISTING of iron, alumine, a larger quantity of filex, and generally a small proportion of carbonate of lime: hardish, lightish, porous, of an earthy texture, imbibing the water in which it is immersed with a hissing noise, crackling when dried and pressed with the thumb, rough, without lustre: when powdered and beat up with water and quicklime, becoming so hard as not to be penetrated by water; easily melting in the fire into a black scoria.

VOLCANIC

VOLCANIC STONE, *Cæmentum tufa*.

Collected into entire cliffs and vast strata about volcanic mountains; of a common form. Found in the neighbourhood of volcanos, particularly in Italy, about Naples and Rome, and consists of compact masses of pozzolano, sand, flaggs, pumice, and other stones of volcanic origin: colour mostly smoke colour, cinereous, blackish, brown, ochraceous, yellowish-grey, or brownish-yellow, rarely reddish, greenish, or variegated: it is commonly magnetic, of an earthy fracture, and not easily decomposed by the action of the air: sometimes it has a small mixture of bones, shells, and other calcareous substances, and then effervesces a little with acids.

TRASS OR TERRAS, *C. terras*.

Forming large strata under the surface of the common soil; of a common form. This substance is met with in the vicinity of the Rhine, near Frankfurt and Cologne, &c. and is there called *tuffstein*, which may be rendered *tufa* or *volcanic stone*. It does not however appear to be a volcanic production, but derived from basaltic rocks. From that part of the Rhine it is commonly imported into Holland, and from thence distributed over Europe. It is much used as a substitute for pozzolana. Artificial terras is made by burning clays or slates that abound with iron, and then grinding them to a fine powder.

CARIOUSUS, ROTTEN STONE.

CONSISTING of alumine, filex, and carbonat of lime, with a small portion of iron: light, soft, porous, falling to powder in water: effervescing with nitric acid, hardening and growing a little red in the fire.

The only species of Rotten-stone, called *Cariosus Anglicus*, is found in Derbyshire, Glamorganshire, and other

other coal-countries, generally over veins of coal: colour isabella-yellow, dull grey, or brown: it easily moulders in the open air, and soon falls to powder in water, for which reason it has been denominated *rotten-stone*. It is principally used for polishing metals and other substances.

ARDESIA, SLATE, &c.

CONSISTING of alumine and flex, with generally a little oxyd of iron and carbonat of lime, and sometimes some magnesia and petroleum: soft, of a slaty texture, generally breaking into discoid fragments, opaque, of a common form, imbibing water, but so slowly as not to be softened; and when moistened exhaling an argillaceous odour. Not effervescing with nitric acid, melting into a turbid scoria by a considerable degree of heat; found in primitive as well as stratified mountains, and when in the former of a greasy lustre, forming entire mountains, or their principal part.

WHETSTONE, *Ardesia novacula*.

A little polished, shining within, subopaque, hardish, greenish-grey, making a whitish mark. It is found in shistose mountains, forming considerable layers, chiefly in the Levant, near Lauestein in Bareith, Siberia, and near Frieberg in Saxony. Fracture slaty, approaching to shivery; does not adhere to the tongue; receives an imperfect polish, hardens in the air and in oil, and when saturated with the latter makes an excellent whetstone.

SLATE, *A. regularis*.

A little polished, rather hard, bluish-black with a cinereous streak, with straight foliations. Found in many mountains of Britain, and various parts of Europe, generally in layers, and frequently marked with the impression of living bodies and plants: when broken,

broken, shines a little from a mixture of micaceous particles or granulations of quartz; does not adhere to the tongue, or imbibe water, and is principally used for the covering of houses. There is a very extensive quarry of slate at Stonesfield, near Woodstock, which has the property of being easily separated into laminæ by mechanical means; or even by the action of the atmosphere. From its being employed very generally for covering the roofs of houses, it has been called *Lapis tegularis*. The property of being thus easily separated into laminæ depends partly upon the proportion of clay contained in it, (for this property is in general more remarkable in proportion to the quantity of clay contained,) and partly upon the nature of its original deposition: for the stone of some parts of the quarry contains a considerable quantity of minute shells resembling millet-seeds; and it seems worth observation, as connected with the schistose property of the stone, that the deposition of shells is more abundant on the surface than in the substance of the laminæ.

BLACK CHALK, *Ardesia nigricans*.

Deep black, meagre, very soft, soiling the fingers, making a black streak, of an incurved slaty texture, breaking into discoid fragments or long splinters, becoming reddish-grey in the fire. Found in Westrogoth, Franconia, and Italy, in solid masses, without lustre: adheres slightly to the tongue, feels smooth, assumes a polish from a knife, gives a black streak and marks black; does not readily moulder in water, or effervesce or dissolve in acids; when heated to redness becomes reddish-grey. This substance is a considerable object of traffic in Italy; and hence by artists is sometimes called *pierre d'Italie*, or Italian stone.

BASALTES, BASALT.

CONSISTING of a large proportion of silice, with a smaller proportion of alumine and oxyd of iron, and often a little lime, magnesia, oxyd of manganese, and soda: opaque, inconspicuous, meagre, generally becoming greyish when rubbed with a knife, breaking into indeterminate fragments, mouldering in the air into argil: not effervescing with nitric acid, melting before the blow-pipe into a black glass attracted by the magnet.

The origin of the name *basaltes* is dubious; and its application is by no means well-defined; for Dolomieu observes, that many substances of a different nature so much resemble each other in analysis as well as appearance, that it is difficult to fix the application of the name to any one. The same observation holds with respect to the *whin-stone* of Scotland. It will be convenient therefore, says Dr. Kidd, to consider basalt and whinstone as synonymous; and to give a separate description of various substances that have been considered as subordinate to these; or, where the substances themselves cannot be ascertained, an explanation of their names.

That all basalt has been originally in a state of igneous fusion is highly probable; and it appears also probable, from the experiments of Mr. Gregory Watt, that the basalt in cooling crystallized in a confused manner round numerous central points within its substance: that the crystallization radiating from these central points in all directions produced numerous spherical masses; the process of crystallization stopping as soon as the radii of two adjoining crystalline centres had extended sufficiently to come into contact with each other. But as he observed also that these radii did not proceed independently of each other, but advanced periodically by regular steps to points equidistant from the centre; thus forming a radiated and at the same time a concentric structure;
he

he conceives that the disintegration of basalt of this kind, proceeding in an inverted order, from the circumference towards the centre, would give rise to the production of those spherical masses : and this opinion is confirmed by the evident appearance of a concentric disintegration that occasionally takes place. Stirling castle stands on a basaltic rock remarkably disposed to undergo the disintegration above described.

The low degree of heat at which basalt melts was once made the ground of an argument against that part of Dr. Hutton's theory which supposes that this substance was consolidated from a state of igneous fusion : for it was argued that in this case basalt would in its characters have resembled the black glass into which by heat it may easily be converted : but the force of this argument has been completely subverted by the results of the experiments of Sir James Hall. By these it has been proved that of the same mass of basalt reduced to a uniform glass, any part will retain the vitreous character if cooled rapidly : and any part if cooled very slowly will resume a texture and appearance so nearly resembling the original rock from which it was detached, that even an experienced eye shall scarcely be able to detect a difference. Certainly there will be no greater difference than might be found between two portions taken from different parts of the same rock.

Upon the whole, an extensive field of enquiry is here offered to the geological philosopher in his attempts to ascertain the alterations to which the globe has been subjected. The labours of the chemist and mineralogist equally co-operate in these researches, and tend likewise to show what useful purposes this and other substances may be applied to. Bergman found that the component parts of various specimens of basaltes were at a medium 52 parts of siliceous earth, 15 pure clay, 8 chalk or mild calcareous earth, and 25 iron.

The differences seems however to be considerable for Faujas de St. Fond gives these proportions: 46 flint, 30 clay, 10 lime, 6 magnesia, and 8 iron.

COLUMNAR BASALT, *B. columnaris*.

Specific characters, colour dull, texture compact, hardish, tenaceous, spontaneously breaking into prismatic granular fragments.

The columnar basalt seems to have been originally found in Ethiopsea, and fragments of it in the river Tmolus, and some other places. We now have it frequently, both in columns and small pieces, in Spain, Russia, Poland, near Dresden, and in Silesia; but the largest block of this stone that ever was seen was placed, according to Pliny, by Vespasian in the Temple of Peace. It represented the figure of Nilus, with sixteen children playing about it, denoting as many cubits of the rise of the river. The statue of Memnon in the temple of Serapis at Thebes, which sounded at the rising of the sun, was also made of the same material, if we may believe this author. Most of the Egyptian figures are likewise made of basalt.

The most remarkable and most plentiful stores of the columnar basalt are undoubtedly the Giants' Causeway in Ireland, and Fingal's Cave in Staffa, one of the Western Isles of Scotland. Great quantities of basalt are likewise found in the neighbourhood of Mount Etna in Sicily, of Hecla in Iceland, and of the volcano in the Island of Bourbon. These are the only three active volcanoes in whose neighbourhood it is known to be met with; but it is also found in the extinguished volcanoes in Italy, though not in the neighbourhood of Vesuvius. In Iceland the basalt rises far up the country, runs into the sea, crosses at the bottom, and rises again on the opposite land.

In *Staffa*, the whole end of the island is supported by natural ranges of pillars, mostly above fifty feet high, standing in natural colonnades, according as the
bays

bays and points of land have formed themselves, upon a firm basis of solid unformed rock. Above these, the stratum, which reaches to the soil or surface of the island, varies in thickness, as the island itself is formed into hills or valley, each hill which hangs over the valleys below forming an ample pediment. Some of these, above sixty feet in thickness from the base to the point, are formed by the sloping of the hill on each side, almost into the shape of those used in architecture. The columns of the Giants' Causeway rarely consist of more than six sides, and are sometimes separated by veins of red ochre. The columns of Staffa often have eight or nine sides. The separate columns of both places are disposed to separate transversely so as to form a flat concave and flat convex surface exactly corresponding with each other: and these transverse fractures sometimes occur so frequently in the same column, that the distance between two of them in many instances does not equal the diameter of the column. But Sir Joseph Banks observes, that the bending pillars of Staffa differ considerably from those of the Giants' Causeway. In Staffa they lie down on their sides, each forming the segment of a circle; and, in one place, a small mass of them very much resembles the ribs of a ship. Those of the Giants' Causeway which he saw, ran along the face of a high cliff, bent in the middle, as if unable, at their first formation, to support the mass of incumbent earth.

The *Giants' Causeway* is a lofty promontory in the county of Antrim, on the north-east coast of Ireland, which exhibits the most magnificent arrangement of basaltic columns in the known world. The principal causeway consists of an irregular arrangement of many hundred thousands of columns, almost all of a pentagonal figure, but so closely and compactly situated on their sides, though perfectly distinct from top to bottom, that scarcely any thing can be introduced
between

between them. The columns are of an unequal height and breadth. How deep they descend below the strand, had not been ascertained. This grand arrangement extends nearly two hundred yards, entirely visible at low water. The breadth of the principal or grand causeway, which runs out in one continued range of columns, is, in general, from twenty to thirty feet; at one place or two it may be nearly forty. The tops of these innumerable columns being nearly of an equal height, they form a grand and singular parade, rather inclining to the water's edge. But from high-water mark, as it is perpetually washed by the beating of the waves on every return of the tide, the platform lowers considerably, and becomes dangerous to be walked on without the greatest care. At the distance of 150 yards from the cliff, it turns a little to the east, and then sinks into the sea. The figure of these columns is almost unexceptionably pentagonal, or composed of five sides; yet what is very extraordinary, and particularly curious, there are not two columns in ten thousand to be found, that either have their sides equal among themselves, or whose figures are alike. Nor is the composition of these columns or pillars less deserving the attention of the curious spectator. They are not of one solid stone in an upright position; but composed of several short lengths, curiously joined, not with flat surfaces, but articulated into each other like ball and socket, or like the joints in the vertebræ of some of the larger kinds of fish, the one end at the joint having a cavity, into which the convex end of the opposite is exactly fitted. This is not visible but by disjoining the two stones; the depth of the concavity or convexity is generally about three or four inches; and, what is still farther remarkable of the joint, the convexity, and the correspondent concavity, is not conformed to the external angular figure of the column, but exactly round, and as large as the size or diameter of the column

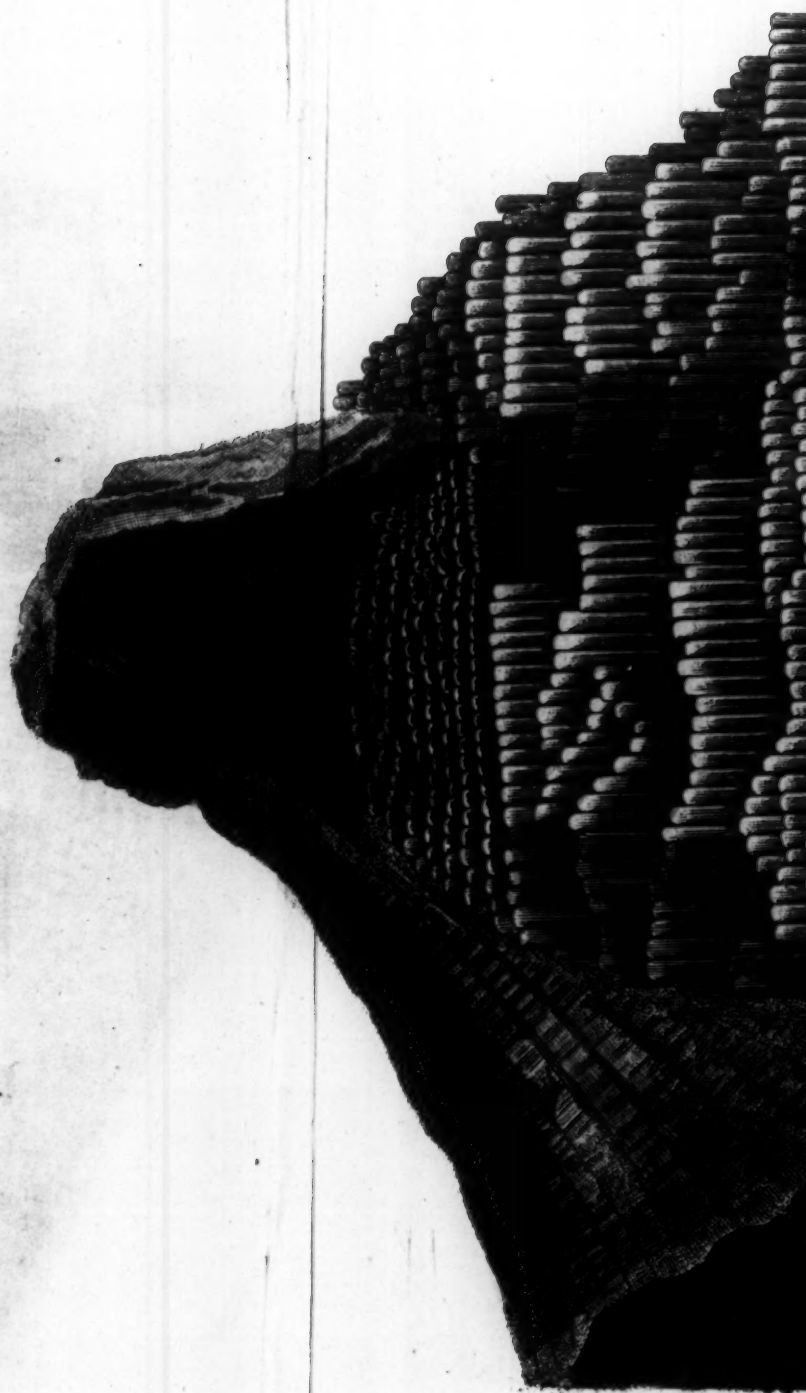
lumn will admit; and consequently, as the angles of these columns are in general extremely unequal, the circular edges of the joint are seldom coincident with more than two or three sides of the pentagonal, and from the edge of the circular part of the joint to the exterior sides and angles they are quite plain. It is still further remarkable, that the articulations of these joints are frequently inverted; in some the concavity is upwards, in others the reverse. The length also of these particular stones, from joint to joint, is various: in general, they are from eighteen to twenty-four inches long; and, for the most part, longer towards the bottom of the columns than nearer the top, and the articulation of the joints something deeper. The size likewise of the columns is as different as their length and figure; in general, they are from fifteen to twenty inches in diameter. There are really no traces of uniformity or design discovered throughout the whole combination, except in the form of the joint, which is invariably by an articulation of the convex into the concave of the piece next above or below it; nor are there any traces of a finishing in any part, either in height, length, or breadth, of this curious causeway. If there is here and there a smooth top to any of the columns above water, there are others just by, of equal height, that are more or less convex or concave, which show them to have been joined to pieces that have been washed away or broken off. Some of these columns are between thirty and forty feet high, from the top of the sloping bank below them; and, being longest in the middle of the arrangement, shortening on either hand in view, they have obtained the appellation of *organs*, from a rude likeness in this particular to the exterior tubes of that instrument; and, as there are few broken pieces on the strand near it, it is probable that the outside range of columns that now appears is really the original exterior line, to the seaward, of this collection.

The

The stone is black, close, and uniform; the varieties of colour are blue, reddish, and grey; and of all kinds of grain, from extreme fineness to the coarse granulated appearance of a stone which resembles imperfect granite, abounding in crystals of horn chiefly black, though sometimes of various colours. Though the stone be in general compact and homogeneous; yet it is remarkable, that the upper joint of each pillar, where it can be ascertained with any certainty, is always rudely formed and cellular. The great pillars also in the capes and mountains frequently abound in these air-holes through all their parts, which sometimes contain fine clay, and other apparently foreign-bodies: and the irregular basaltes beginning where the pillars cease, or lying over them, is in general extremely honey-combed; containing in its cells crystals of zeolite, little morsels of fine brown clay, sometimes very pure steatite, and in a few instances bits of agate.

The *Rocks of the Cyclops*, in the neighbourhood of Etna, exhibit very magnificent basaltic pillars, which we have represented in the annexed Plate. Near these rocks is an island, one half of which is composed of lava, on a base of basaltes; above which there is a crust of pozzolana, combined with a white calcareous matter, hard and compact: and which, as it is composed by the action of the air, appears like a piece of knotty porous wood. The island was formerly inhabited; and there still remains a flight of steps leading from the shore to the ruins of some houses which appear to have been hewn in the rock. These basaltic columns are of various sizes and forms; some square, others hexagonal, heptagonal, or octagonal. One half of this rock is composed of perpendicular columns; the other of another species of basaltes disposed in inclined, and almost rectilinear layers. These are in contact with the columns, and are as closely connected with them as they are with one another. It is also to be remarked, that most of the layers are subdivided as they rise upwards;

BASALTES





View of the Basaltic Rocks of the Cyclops.

London published by the Rev. George Smith & Co. 1840.

J. Chapman sc.

upwards; so that, towards their upper extremities, one layer presents to the eye sometimes one, sometimes two, and sometimes three, divisions. The fragments of basaltés taken off from these layers are of a rhomboidal figure, because they break obliquely. These layers, though inclined towards the base, become almost perpendicular towards the upper part of the rock, where they appear united in a point, and overtop most of the visible and elevated parts of the prismatic columns. These columns terminate in such a manner as to form a kind of staircase. They appear to rise under a species of clay with which they are covered at one extremity, till they re-unite themselves with the point which is formed by the most elevated parts of the layers of basaltés beside them.

The *Promontory of Castel d'Iaci*, which terminates the basis of Etna, is almost entirely composed of basaltés, but of a variety different from the former. It consists of a great number of cylinders from the diameter of six inches to that of twenty feet. Some of these are solid, others hollow like cannon; some extended in layers, others similar to carrots of tobacco, consisting of a number of pieces squeezed together. Some of these cylinders are straight, others curved into a variety of forms. Some look like globes inclosed in the rocks; and in the fracture of these globes we perceive the strata of which they are composed. These are delineated at the foot of the same Plate. The little mounts into which it appears to be collected, are sometimes only one foot in diameter, sometimes six. They are composed of small prisms or needles, or of cubic trapezoids, and consist of a matter distinguished by the name of *dirty lava*. It is made up of pozzolana, consolidated by a certain liquid, which, while it has communicated solidity to the pozzolana, has at the same time suffered that substance to shrink considerably, in such a manner as to leave large chinks between the pieces of basaltés, which are thus

formed by the operation of the liquid on the pozzolana. It appears also to have insinuated itself into the clay with which the promontory is covered; which has become hard in its turn, and which has also split into chinks that appear to contain a kind of hard matter. These descriptions and figures will serve to give a pretty correct idea of the appearance of basales, which is generally accounted a kind of marble.

PYRAMIDAL BASALT, *B. pyramidalis*.

Specific character, spontaneously falling into pyramidal fragments. Occurs in the mountains of Bohemia, near Auffig, in elongated three-sided fragments; and in Hungary, near Schemnitz and Cremnitz, in four-sided fragments.

WACKEN, *Basaltus wacca*.

Soft, fragile, compact, a little glossy when rubbed, not falling spontaneously into fragments. Found in the mountains of Bohemia and Saxony, sometimes in entire strata, sometimes in thin layers under or between basalt. Colour cinereous, or greenish, or blackish, or yellowish, and often contains veins of metallic ores: lustre none, fracture even, texture earthy, opaque, soft, easily broken, and feels slightly greasy. It withers by exposure to the atmosphere, and then becomes more grey; frequently contains black mica, but never olivin.

TRAPP, *Basaltus trapezum*.

Hardish, compact, imbibing water, growing reddish in the air and mouldering into lamellar pieces, crackling and breaking with explosion in the fire. Walerius calls this species *Corneus trapezius*; partly from that horny toughness which belongs to it in common with several other minerals called *hornstones*, and partly from its natural disposition to separate into trapezoidal or irregularly four-sided figures somewhat resembling

sembling steps or stairs; the Swedish word *trapp* signifying a step or stair. Wallerius observes that he should have been inclined to call it *Corneus scalaris*, but for the coincidence between the terms *trapp* and *trapezius* as applicable to the form which its fragments are disposed to assume. It is found in the mountains of Britain, Scandinavia, Switzerland, and Germany, forming vast masses, and often broken into three, four, or five, sided prisms. Colour greyish, bluish, or purplish-black, black, blackish or reddish-brown; and frequently containing basaltine, quartz, crystallized carbonat of lime, feldspar, and olivin: hence it is frequently porous, cellular, or cavernous, from the decomposition or falling-out of these stones: fracture earthy or fine splintery, often uneven. It effervesces a little with acids, and may be melted into blackish-green glass. There are three varieties.

1. *Toadstone*. Of a dark brownish-grey colour, abounding with cavities filled with crystallized carbonat of lime, which from the destruction or decomposition of the crystals are often empty. Contains silica 63, alumine 14, mild carbonat of lime 7, oxyd of iron 16.

2. *Ferrilite*. This term has been applied by Mr. Kirwan to the variety commonly known by the name of *Rowley ragg*: which is either a corruption of *Rowley regis*, the name of the place near which it is found; or is given to it in common with many other substances which by the common people are called *ragg-stones*. The following account of it is taken from Mr. Gregory Watt's paper in the Philosophical Transactions for 1804. He says it is met with in the south-west part of Staffordshire: that it is easily fusible; of an iron grey colour approaching to black; and that it reflects light from a number of brilliant spots or striæ, some of which seem to be feldspar; others, hornblende: Judging from its colour and its alteration by exposure, the iron, he thinks, is in a low state of oxydation: which

which is also confirmed by the magnetic property of the mountains from whence it comes; which, according to Dr. Plott's observations, turned the needle six degrees from its proper direction. Mr. Watt made numerous experiments upon this substance, corresponding with those which had been previously made by Sir James Hall on the different effects produced by the rapid or slow cooling of vitrified whin or basalt; directing his attention principally to the crystallization that took place in the interior. By withdrawing the heat very gradually from the vitrified mass, he found that the hornblende became as distinctly crystallized as in the natural substance; sometimes even more so. And he ascertained many very important points as to the nature and process of that crystallization which took place in this mineral substance during its consolidation from igneous fusion.

3. *Whin-stone*. Those, who do not apply this term as a synonyme with basalt in general, restrict it to a variety of this particular species, of a blue or greyish black colour, and rather hard; found in detached fragments, or forming dykes in mines. Very plentiful in Scotland.

LAVA, LAVA.

GENERIC characters, Consisting of alumine, with a larger portion of silice and oxyd of iron, and frequently a little carbonat of lime and carbonat of magnesia. Generally of a dull colour, becoming hoary when scraped, meagre, breaking into indeterminate fragments, mouldering into argil in the air. Produced by the internal fires of volcanic mountains from which it is thrown out, and melting again into a black glass.

According to Kirwan, the word *lava* is derived from the Gothic word *lauffen*, to run. Lava often resembles porous basalt; but it is impossible to define a lava accurately, because not only different volcanoes

volcanoes but even the same volcanoes produce different lavas at different times; the internal fire perhaps taking different directions, and acting on different substances. Many lavas affect the magnetic needle. A lava analysed by Bergman gave the following results: silice 49, alumine 35, lime 4, oxyd of iron 12; but one species, the pumice-stone, contains $77\frac{1}{2}$ of silice. Many dark-coloured lavas become white, in consequence of the neighbourhood of acid sulphureous vapours; for these, acting on the iron and clay contained in the lavas, form sulphat of alumine and of iron; which being afterwards washed away, the lava remains white. Some lavas are naturally white. Lavas often undergo a concentric disintegration after the manner of some whin-stones. Dolomieu says that he has seen, in the ruins of ancient Rome, blocks of granite and porphyry undergoing a similar disintegration from the action of the weather. Almost all lavas undergo disintegration by exposure to air; but the time required for this effect is very different in different instances. Some are decomposed in an age or two: some, not under a thousand years. Hence many occasions of false judgment have arisen with respect to the length of time employed in the accumulations of soils that have been formed by the disintegration of lava. This observation, which Dolomieu first made, has been confirmed by Spallanzani and others: and Spallanzani exposes the errors which Brydone and Count Borch fell into relative to the age of the earth, by computing from the depth of soil which had been accumulated from disintegrated lava; the process advancing by no fixed ratio. Thus Count Borch mentions a lava which flowed in the year 1329, on which soil had accumulated to the depth of eight inches; while on the other hand Spallanzani mentions a lava which rushed into the sea in the year 1320, but still preserves in every part its hardness and sterility.

Those lavas which are the lightest and least vitrified,
and

and at the same time contain the greatest proportion of alumine and oxyd of iron, are the most easily disintegrated: and where the proportions of the constituent parts of a disintegrated lava are such, as to be capable of retaining a just portion of moisture for the longest time, the fertility of the resulting soil is greatest. Nothing can be more fertile than the fields of Catania, and all the base of Etna. The lava of Vesuvius is used in paving the streets of Naples; and according to Winkelman the streets of ancient Rome were probably paved with the same substance. But volcanic eruptions do not invariably produce lava: the volcanoes of Quito, the flames of which are sometimes elevated three thousand feet, have never produced a single drop of running lava. They send forth water, inflammable air, dirt, and clay impregnated with coaly matter. Similar muddy eruptions occasionally take place in other volcanoes also. There are six species.

COMPACT LAVA, *L. compacta*.

Nearly opaque, compact, hardish, of a conchoidal texture. Found in volcanic mountains and their neighbourhood, appearing to have been fused by the action of fire, but not vitrified, and becoming, when cooled, compact, close, and solid, and bearing the resemblance of its original mineral. Colour generally blackish, sometimes grey, brown, or red, rarely white, very rarely green or blue: its substance is so very little porous as to admit being cut into slabs with an almost entire surface, and polished like marble; fracture earthy or fine splintery, more rarely foliated. Contains often hornblende, white garnets, olivin, calcareous spar, mica, shorl, &c.

VITREOUS LAVA, *L. vitrea*.

Diaphanous, shining, compact, hard, of a conchoidal texture. Found about volcanic mountains in
New

New Spain, Peru, Hecla, Vesuvius, and sometimes in places where subterraneous fires have taken place either from pyrites or in coal-pits: contains generally other substances imbedded, and is more or less transparent; colour generally black, rarely cinereous, greenish, bluish, or white, sometimes prismatic: usually of a common, rarely of a stalactitical, globular, or pyramidal, form: melts with more difficulty than other species, on account of its containing less iron, carbonat of lime, and magnesia: is frequently so hard as to strike fire with steel.

SPONGY LAVA, or SCORIA, *L. scoriacea*.

Vesicular, rough, shining internally, of a conchoidal texture. Found in streams of volcanic lava, generally covering the lava compacta, black or brown, with often a mixture of heterogeneous matters: the surface appears full of empty bubbles, often disposed in an undulate manner.

POROUS or CELLULAR LAVA, *L. porosa*.

Opake, without lustre, porous, lightish. Found in volcanic mountains and their neighbourhood, more rarely in those which have been extinguished, and seems rather to have been thrown from the crater than run over at the sides: colour black or brown, sometimes reddish-brown: it probably contains more carbonat of magnesia than the rest, and is more subject to destruction than compact lava: its pores are larger near the surface than towards the centre.

PUMICE-STONE, *Lava pumex*.

Opake, without lustre, parallel, fibrous, porous, light, rough. Found in the ashes of most volcanic mountains, from whence it is washed down into the sea. Colour grey, greyish-white, brown, or reddish, rarely yellowish: the fibres are generally parallel, more or less discernible, and have a silky lustre: does not effervesce with acids, melts into a white enamel.

Pumice

Pumice may be considered as a loose vitrified lava, entirely devoid of iron. The pores of pumice, when observed in the undivided mass, are always in the direction of the current of the lava of which the pumice makes a part : in proportion as it is nearer or further from the surface, the pumice is more or less porous; and the lowermost part of the bed is generally completely compact, and passes into the state of a dense glass. In some specimens the complete transition from the one to the other state may be traced by very delicate gradations.

There appears to be the same relation between compact and porous pumice that there is between compact and porous lava ; the inferior part of a bed of lava being always compact, the superior porous. Most of the pumice of commerce comes from the Island of Lipari. It is used in polishing various substances.

BASTARD LAVA, *L. spuria*.

Originating from substances which have been ignited by burning strata of fossil coals. Found in Bohemia, near Belin, Seidschuz, Laun, and Lobosau, in Wastavia near Datweiler, in Hungary on Mount Schater, porous or compact, more or less ponderous, of a reddish, cinereous, black, blue, iron, steel, or iridescent colour.

MICA, MICA.

CONSISTING of silic and alumine, with a small proportion of oxyd of iron, and generally a little magnesia and lime: glabrous, meagre, shining, spontaneously falling into granular fragments, easily breaking into discoid fragments, lightish, parasitical: fusible before the blow-pipe into a white or coloured enamel.

Mica is so called from its glittering appearance; by which it may in general be easily recognized in compound

compound rocks, as granite, gneis, &c. When distinctly crystallized, which does not often happen, its form is usually an hexhedral plate; and, according to Saussure, these plates are almost always set on their edges. Sometimes a great number being closely applied to each other produce a six-sided prism. In whatever form mica occurs, it has the peculiar property of being divisible into laminæ to any extent; which often, simply in consequence of their extreme tenacity, reflect the colours of the rainbow. Haüy says that by calculation he found the thickness of some of these laminæ to be not more than the six hundred thousandth part of an inch. When the crystalline laminæ of mica are in complete contact with each other throughout the whole extent of their surface, they are usually transparent: otherwise they are not, unless divided into very thin plates. Mica is a constituent part of almost all granite; and appears to have been originally crystallized in the body of that compound rock. It is also commonly met with in sand-stones and secondary schisti: in which case it is hardly to be considered as the result of crystallization; but as the detritus of crystallized mica, that has been subsequently deposited with the other component parts of the strata in which it occurs.

MUSCOVY TALC, *Mica membranacea.*

Transparent, with large parallel elastic easily separable plates. Found in Malabar, Siberia, Russia, Finland, France, and near Geneva, in large plates, which are often substituted in Russia instead of glass; and, when employed in the windows of ships of war, which till lately was a common custom, has the advantage of glass in not being liable to be shattered by the shock of cannon: but by exposure it loses its transparency. Not being easily injured by fire, it makes a very good substitute for glass in the construction of lanterns, &c.

Besides the name of *Vitrum Moscoviticum*, or Muscovite glass, it is sometimes called *Glacies Mariæ*; because employed, when broken into small pieces or scales, in frosting images of the Virgin Mary. Its specific gravity varies from 2.65 to 2.93: and it contains silic 50, alumine 35, magnesia, 1.35, lime 13.3, oxyd of iron 7.

SCALY MICA, *M. squamosa*.

Somewhat opaque, with smaller scattered incurved foliations. It is sometimes of a silvery colour, and sometimes of a gold colour; and, from its lustre, joined with its colour, has occasionally been really mistaken for silver or gold. Miners call this, *cat-gold* or *cat-silver*. There is a patch of mica of this kind on the ridge of Malvern, between the well-house and the town.

White or greenish mica may be distinguished from talc by its elasticity, and by not possessing the unctuous feel of the latter substance; from selenite, by remaining unaltered in a low red heat; from sulphuret of molybdena, by its elasticity, and by not staining paper when rubbed upon it; from crystallized oxyd of uranium, by its elasticity, and by not passing into the state of a black scoria under the action of the blow-pipe: from grey micaceous iron ore, by being less fragile, and by adhering less easily to the fingers when crumbled; also, by not being magnetic, as that often is.

LEPIDOLITE, *M. lepidolithus*.

With scattered, flat, cohering, pale violet, scales. This is found in Moravia and Sudermania, mixed with granite in large amorphous masses, and is composed of thin plates which separate easily. Colour of the mass violet blue, of the thin plates silvery white: powder white with a pale red tinge. Before the blow-pipe it froths, and melts easily into a white

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white semitransparent enamel full of bubbles: dissolves borax with effervescence, and communicates no colour to it: effervesces slightly with soda, and melts into a mass spotted with red: with microcosmic salt, it gives a pearl-colour globule. Contains silic 53, alumine 20, potash 18, fluat of lime 5, oxyd of manganese 3, oxyd of iron 1.

OPALUS, OPAL.

CONSISTING of alumine, the greater proportion of silic, with a little oxyd of iron, and generally some carbonat of magnesia and of lime: hardish, shining, hardly ever opaque, of a conchoidal texture, light, breaking into indeterminate fragments, parasitical, generally of a common form, easily cracking into clefts; melting with the greatest difficulty. When not opaque there is a disposition in this substance to refract the rays of light in a very remarkable manner: the colour most in esteem, as arising from this refraction, is green. The effect is produced in consequence of the presence of numerous small fractures or fissures in the interior of the opal, the intervals of which produce a varying refraction of the rays of light. All these colours disappear when the substance of the opal is reduced by mechanical means to very minute particles.

HYDROPHANOUS OPAL, *O. hydrophanus*.

Specific characters, somewhat opaque, becoming transparent and changing its colour in liquids, adhering to the tongue. Found in the Feroe islands, Iceland, Brittany, Hungary, Silesia, and Germany, generally accompanying other stones of the genus, or in the state of incrustation, in contact with chalcedony, prase, chrysoprase, serpentine, granite, nephrite, jasper, porphyry, and indurated clay. Colour white, yellow, red, or green: becomes gradually transparent when soaked in water by imbibing the liquid, and is sometimes,

times, though rarely, found in the form of a three-sided pyramid. Contains silice 93, alumine 1 or 2, water, inflammable matter, and air, 5, with sometimes a little iron.

PITCH STONE, *O. piceus*.

Of a waxy lustre, and imperfectly conchoidal texture. Found in amorphous masses of various size, in France, Germany, Saxony, and various parts of Europe, and in New Spain. Colour greyish-black, greenish-brown, bluish-grey, leek or olive-green, red, or yellowish, transparent, semitransparent, or opaque, frequently presenting large or small grained distinct concretions: lustre a little greasy.

WOOD OPAL, *O. ligneus*.

Nearly opaque, breaking longitudinally into fibrous fractures, spontaneously falling into crustose fragments. Found in Hungary, in large masses which have the form of wood, of a milk reddish, or yellowish-white, brown, or hyacinth, colour: has a shining surface, and is generally semitransparent on the edges: fracture when broken transversely conchoidal, when broken longitudinally exhibiting the texture of wood: is very brittle, and considered as fragments of wood impregnated with semi-opal.

WAX OPAL, *O. cereus*.

Semitransparent, light, yellow, of a perfectly conchoidal texture. Found in Poland and Hungary, in rounded fragments, and often imbedded in jasper and indurated clay; its colour is sometimes a waxen, sometimes a honey yellow, frequently verging to brown: it is brittle, shining very much internally, and breaks into acute and often nearly discoid fragments.

MENILITES, or SEMI-OPAL, *O. vilior*.

Hard, lightish, easily breaking into acute fragments.
Found

Found in Poland, Bohemia, Hungary, Austria, Saxony, Germany, and Menil-le-Montant near Paris, whence the name. Colour various shades of white, grey, yellow, red, brown, often mixed together: diaphanous, or opaque, rarely transparent: texture more or less perfectly conchaceous, and its lustre more or less glassy: is very brittle, and sometimes adheres to the tongue.

COMMON OPAL, *O. vulgaris*.

Reflecting a different colour according to its position as to light, hardish, lightish, diaphanous, breaking into rather obtuse fragments. Found in Poland, Silesia, Saxony, Hungary, and Germany, usually imbedded in other stones, of a common form, rarely kidney-form or botryoidal, shining a little internally, generally sub-opaque. Colour white, yellow, red, green of various mixtures: sometimes it is found inclosing a drop of water: reflects a single colour when held between the eye and the light: it often cracks and becomes decomposed by exposure to the atmosphere. Contains silica 98, oxyd of iron 1, alumine 1.

REAL OR NOBLE OPAL, *O. nobilis*.

Semitransparent, shining very much internally, light, hardish, reflecting various bright colours according to its position as to light: breaking into acute fragments. Found at the foot of the Carpathian mountains, and in Hungary, in solid pieces, and sometimes incorporated into other stones. Colour various, the white often reflecting a yellowish, greenish, or reddish, effulgence resembling a flame, when placed between the eye and the light. When heated it becomes opaque, and is sometimes decomposed by exposure to the atmosphere.

ZEOLITHUS, ZEOLITE.

CONSISTING of a little alumine, and a large proportion

portion of flint, with frequently a little carbonat of lime, and a small quantity of oxyd of iron and water: lighuish, generally breaking into indeterminate fragments, parasitical, falling spontaneously into granular fragments: soluble in nitric acid without effervescence, and often forming with it a gelatinous mass; easily frothing before the blow-pipe and emitting a phosphorescent light, and melting into a white semi-transparent enamel.

Zeolite occurs principally in rocks of the basaltic order, accompanied by calcareous spar and calcedony. These several substances, disseminated through the rock containing them in the form of irregularly-shaped nodules, produce that appearance, which has given rise to the term *amygdaloid*; the white nodules appearing like almonds imbedded in the surrounding substance, and being particularly conspicuous in consequence of the darker colour of the matrix containing them. These nodules sometimes moulder away, leaving the space vacant which they had occupied: and hence the origin of those cavities in some varieties of basalt. This effect is probably owing to a loss of the water of crystallization; and in proportion as the zeolite becomes of an earthy or farinaceous consistence its electric property is weakened. Zeolite is commonly crystallized in delicate prismatic fibres, which radiate from a common centre.

LAMELLAR ZEOLITE, OR STILBITE, *Z. lamellosus*.

Specific character, solid, shining internally, white with often a shade of red, diaphanous, lamellar, with the foliations undulate and brittle. Häuy gave it the name of *stilbite* from its pearly lustre. It is found in Ostrogoth and Iceland, sometimes breaking into crustose fragments, and is rather hard.

FIBROUS ZEOLITE, OR MESOTYPE, *L. fibrosus*.

Solid, shining like mother of pearl, fibrous with the fibres

fibres convergent. Called *mesotype* by Haüy, because its primitive form is intermediate between the primitive forms of two other minerals, with which it is often confounded. It is not much harder than carbonat of lime. Its primitive form is a prism at right angles with its base, which is a square. It is found in Scotland, and various parts of Europe, in basaltes, and in the lavas of Iceland, often accompanied with chalcodony, rarely in Hercynia. Colour white, reddish, brownish, yellow, or cinereous: lustre silky or pearly: refracts double, and absorbs water: when heated it becomes electric: before the blow-pipe it froths, emits a phosphorescent light, and melts into a white semi-transparent enamel soluble in acids: dissolves slowly in acids, without effervescence, and is converted at last into a jelly: the fibres are sometimes fascicled, sometimes stellate and aggregate into a more or less perfectly globular form.

PREHNITE, OR GREEN ZEOLITE, *Z. viridis*.

Apple green, hard, semipellucid, of a partly foliated partly radiate texture. This mineral was named from Col. Prehn, who discovered it at the Cape of Good Hope; and was at first mistaken for several other substances, as chrysoprase, the chrysolite, &c. It was afterwards classed as a variety of fibrous zeolite; but is now considered as a distinct species. Prehnite frequently occurs in irregularly crystalline masses of a white, or green, or yellowish, colour; these when broken present numerous small radiated surfaces of a circular form. It is distinguished from zeolite in not being converted into a jelly by nitric acid.

Since its first discovery, at the Cape of Good Hope, it has been met with in the Tyrol, in Dauphiny, and in the basaltic rocks near Dumbarton, and other places in Scotland. It is sometimes so hard as to strike fire with steel, and to admit a fine polish. Before the

the blowpipe it foams and swells more than other species, and melts into a brown enamel, smooth on the outside, but spongy and porous underneath.

CYANITE, OR SAPPARE, *Z. cyanites*.

Very brittle, transparent, shining, ponderous, hardish, striking fire with steel, breaking transversely into long splinters, texture foliated in a radiate manner. Found in Scotland, on the Carpathian mountains, on St. Gothard's in Switzerland, near Lyons, in Siberia, Transylvania, and at Zitterthal in Tyrol. Colour white, with shades of sky or Prussian blue, sometimes bluish-grey, or yellowish-grey streaked with azure or deep blue, often in spots reflecting a silvery white: found in distinct lamellar concretions, which are in part accumulated in grains, and feels somewhat greasy: texture foliated; fracture radiated, with the rays curved and interlaced: the surface is longitudinally striate: the primitive form of its crystals is a four-sided oblique prism, but is sometimes crystallized in six-sided prisms: before the blowpipe it becomes almost perfectly white, but does not melt. In consequence of its infusibility, Saussure employed the laminæ of this substance for the purpose of attaching to them particles of other minerals during their exposure to the action of the blowpipe. The matrix of cyanite is commonly talc, gneiss, or micaceous schistus: the most beautiful specimens are found in talc, in Mount St. Gothard. It may be distinguished from mica, by its infusibility and want of elasticity: from actinolite, by its infusibility: from sapphire, or even blue quartz, by yielding to the impression of the file. By Haüy it is called *disthène*: this name has a reference to the double electric power of the substance; some of its crystals being positively, others negatively, electrified by friction, even though placed under the same circumstances. Its hardness is as nearly as possible equal to that of glass. Specific gravity 3.5. Contains alu-
mine

mine 54, filex 29, lime 2, magnesia 2, oxyd of iron 6.65, water &c. 5.

SCORLUS, SHORL.

GENERIC characters, Consisting of alumine and filex, mostly oxyd of iron, with frequently a little carbonat of magnesia and oxyd of manganese: hard, breaking into indeterminate fragments, shining internally, parasitical; not effervescing with nitric acid, and easily melting into a glass. The word *shorl*, or *schorl* as it is sometimes written, is derived from the name of the village of Schorlaw in Saxony; where the substance first called shorl was found. It has been customary till lately to apply this term to a great variety of crystallized substances, particularly those of a prismatic form.

VOLCANIC SHORL, or LEUCITE, *Sc. granatinus*.

White, hardish, fusible in the fire with some difficulty, easily mouldering. Found in the lavas of Vesuvius, where it appears, according to Kirwan, to have pre-existed in the rocks which were the mother stones or basis of lavas before the eruption, and is not formed by subsequent percolation through, and crystallization in, the melted lava. Colour white or greyish-white: it is always found in crystals, the primitive form of which are either cubes or rhomboidal dodecahedrons: texture foliated: fracture more or less conchoidal. It is sometimes transparent, but opaque when decomposing: its powder causes syrup of violets to assume a green colour: is hardly fusible before the blow-pipe, and gives a white transparent glass with borax. Leucite is sometimes called *white garnet*, from its colour and occasional resemblance in form to the garnet; and by Haüy *amphigène*, because its secondary crystals may be resolved either into a cube, or into a dodecahedral rhomboid; thus having, as it were, a double origin. It may be distinguished from the

Vol. XIV. No. 190. 3 G garnet,

garnet, of which it has been sometimes thought a variety, by its inferior degree of hardness and specific gravity; and by its infusibility: also by its nearly total want of colour; all the varieties of garnet that have yet been discovered having a considerable shade of colour.

GLASSY SHORL, or THUMERSTONE, *Sc. vitreus.*

Brittle, shining, of a minutely conchoidal texture, easily melting before the blow-pipe with froth into a hard black enamel. It has its name from having been first found near Thum in Saxony, since near Bourg Oisans in Dauphiné, in the Pyrenean mountains, and in Norway near Kongsburg. Colour clove-brown, sometimes inclining to red, green, grey, violet, or black: generally found in crystals, the most usual of which are flat rhomboidal parallelopipeds with the opposite edges a little truncated; and resembling the cutting edge of a hatchet, whence Dr. Kidd calls it *axinite*.

VESUVIAN, *Scorlus Vesuvianus.*

Diaphanous, fulvous, in six-sided prismatic crystals. This is the *idocrase* of Haüy: its crystalline forms partake of the nature of other minerals; and the term *idocrase* is meant to express their mixed character. It is sufficiently hard to scratch glass; and has the double refracting power to a considerable degree; but this is not often perceptible, few crystals being sufficiently transparent. By heat it becomes fused into a compact and nearly colourless glass. Primitive form, a prism at right angles with its base; which is very nearly a square. This mineral is met with near Mount Vesuvius, accompanied by hornblende, mica, garnet, and carbonate of lime: but it does not seem ascertained whether the specimens in which it occurs are parts of the mountain itself, or whether they have been ejected from the crater. It has

has also been found in a species of serpentine in Siberia. One of the varieties of the primitive form of vesuvian consists of a prism with sixteen sides, terminated at each extremity by thirty-seven surfaces. Vesuvian may be distinguished from the garnet, when they resemble each other in colour, by its inferior degree of specific gravity; from the hyacinth, with which it has been often confounded, by the same circumstance, and by the inferior degree of its double refracting power; from the Brazilian tourmalin, in not being electric by simple heat. It is most easily confounded with the crysolite; but its colour is rarely so delicate.

BLACK SHORL, or BRAZILIAN TOURMALIN, *Sc.*
genuinus.

Ponderous, opaque, making a pale grey scratch. Found in Cornwall, where it is known under the name of *cockle*; in Ceylon, Madagascar, Spain, Italy, Switzerland, France, Hungary, Saxony, &c. in mass, disseminated and crystallized, generally in granite, gneiss, and other similar rocks: the crystals are three or nine-sided prisms, which when entire are terminated by three-sided pyramids: the surface of the crystals longitudinally streaked; the amorphous kind presents thin straight distinct columnar concretions, sometimes parallel, sometimes divergent or stellate, streaked, and easily separable from each other; very seldom in granular concretions: the surface can be scratched with a hard knife, and when heated or rubbed hard is a little electric: when heated to redness it becomes reddish-brown: is often so rich in iron, as to be attracted by the magnet. The prismatic crystals of tourmalin are disposed to separate transversely, in the same manner as the beryl: one surface of the divided part being concave, the other convex. The prism sometimes approaches to a cylindrical form, in consequence of the great number of the longitudinal striæ

or channels above spoken of. Tourmalines are met with of various colours: the commonest colour is black, or brownish-black; and this is the variety which often is found, in compact radiating fasciculi, in the granite of the Land's End, in Cornwall; and in that compound rock, consisting of a mixture of this mineral and of white quartz, on which Roche-castle stands, near Bodmin in Cornwall.

ELECTRIC SHORL, OR CEYLON TOURMALIN, *Sc. electricus.*

When heated to 200° of Fahrenheit, attracting light bodies by one end, and repelling them by the other. Found in the rivers of Ceylon, in Brasil, Castilia, the islands on the coast of France, Greenland, Norway, Sweden, Swisserland, and Germany, and near Freyburg in Saxony, in granite, gneiss, and other similar rocks, sometimes in amorphous pieces, but more frequently crystallized in three or nine-sided prisms, with four-sided summits; sometimes in grains. Colour generally green, sometimes brown; red, or blue: crystals three, six, or nine, sided prisms, variously truncated, with the faces usually longitudinally striated or channelled; and terminating in a flat irregular pyramid at each extremity: the number of the faces is different in the two pyramids; and that which has the smallest number acquires by heat the negative or resinous electricity; the other, the positive or vitreous: hence the former repels, the latter attracts, light bodies; and, if two crystals of tourmalin suspended by a thread of silk be presented to each other in an electric state, the similar extremities will repel, the dissimilar will attract, each other. The heat best adapted to show the electricity of the tourmalin is from about 100 to 212 of Fahrenheit. It may be rendered electric either by holding it near the fire, or plunging it in hot water for two or three minutes. If heated above a certain point, it ceases to be electric: if heated still further, it recovers its electricity

tricity; but with this difference, that the poles which were before positively become now negatively electrified; and *vice versa*. The electric property sometimes remains for several hours; and, if a crystal in a state of electricity be broken into the smallest pieces, each fragment will have a positive and negative pole. Transparent crystals are most electric; those containing most iron are least electric.

The green tourmalin of Ceylon is sometimes of a beautiful emerald colour; whence it has been erroneously supposed by some, that the emerald was indigenous in that island; whereas no emerald has yet been found there. From a similar error the green tourmalin of Brasil is often called the Brazilian emerald; or, when of a sufficient shade of blue, the Brazilian sapphire. This species is laterally transparent, but not longitudinally; that is, the transparency of the tourmalin is attended by this singular circumstance; that, generally speaking, it only takes place when the light is viewed in a direction perpendicular to the axis of the prism; even when, from the shortness of the prism, its thickness is greater than its length. Fragments of crystallized tourmalin are frequently found in the sand of the Ceylon rivers; and the most beautiful specimens come from that island. Tourmalin is distinguished from hornblende, actinolite, thallite, the chrysolite, and the emerald, in being electric by heat; and by the singular nature of its transparency, above mentioned.

ORDER V. SILICEOUS EARTHS.

This Order includes the diamond and all other precious stones, besides the newly-discovered earths, and sand, &c. &c.

GEMMA, RUBY, SAPPHIRE, &c.

CONSISTING of flint and a larger proportion of alumine, with sometimes a little carbonat of lime and oxyd of iron: meagre to the touch, of a high internal

ternal lustre, very rarely opaque, breaking into indeterminate fragments, parasitical, shining in the dark, attracting light bodies when heated by friction: not melting with alkalies.

TRUE ORIENTAL RUBY, *Gemma rubinus*.

Very hard, ponderous, red, of a foliated texture, which in a contrary direction is conchoidal, not melting or losing its colour in the fire. Found in Brasil and the East Indies, principally in the kingdoms of Peru and Ceylon, and is, except the diamond, the most precious of all the gems. Colour carmine red, sometimes verging to violet, or between carmine and hyacinth red, sometimes red and white, or red and blue, or orange-red: is found in angular pieces, in small pebbles, or in regular six-sided pyramids joined to and opposed base to base: seldom exceeding an inch in size: when finely powdered, melting with borax, though with difficulty, into a greenish glass. Specific gravity from 3.76 to 4.283.

SAPPHIRE, *Gemma sapphirus*.

Very hard, somewhat ponderous, blue, making a white streak, of a slightly incurved lamellar texture, not fusible, but losing its colour in a strong heat. Found in Brasil, the Indies, Persia, Bohemia, and near Puy in Velay, sometimes crystallized, sometimes in rounded masses, the angles being worn off by friction, and is next in value to the ruby. Colour sky-blue, or the shades of Prussian and indigo blue, with sometimes white specks. The crystals are strong, shining, and exhibit a foliated texture transversely striate; they become colourless when heated with microcosmic salt, and emit a great light while burning. Specific gravity 4.

TOPAZ,

TOPAZ, *Gemma topazius.*

Hard, ponderous, yellow, of a foliated texture which is conchoidal when broken transversely, not fusible per se, but losing all its colour in a strong heat. Found in India, Brasil, Russia, Saxony, Bohemia, &c. generally adhering to other substances, though sometimes detached with the angles worn off. Colour a lighter or deeper yellow, most commonly honey-colour, sometimes verging to white or greenish. Its fragments are sometimes irregular, sometimes granular or prismatic: the prisms longitudinally striate, solitary, in pairs, or in threes, disposed in a cruciate manner; often clustered, rarely four-sided, rectangular, or obliquangular, more frequently unequally eight-sided terminated by an irregular four or eight sided pyramid, or ending in a point. It is infusible per se, but melts with borax and microcosmic salt into a clear glass. Specific gravity 3.5.

HYACINTH, *Gemma hyacinthus.*

Hard, lamellar, of a peculiar yellowish-red, in four-sided prisms terminated both sides by a four-sided pyramid, not fusible per se, but losing its colour in a strong heat. Found in the East and Bohemia, in the form of pebbles, in obtuse-angular pieces. Colour yellowish-red with a mixture of brown: the crystals are small, have a smooth surface and foliated texture: they are imitated by heating rock-crystals and putting them into a solution of dragon's blood.

OCCIDENTAL OR BRASILIAN RUBY, *Gemma rubicellus.*

Hard, of a reddish colour verging to pale yellow, not fusible, but losing its colour in a strong heat. Found in South America; is softer than the true oriental ruby, and of a much inferior colour: fracture foliated.

BALAS,

BALAS, or SPINELL RUBY, *Gemma spinellus*.

Hard, of a pale red colour inclining to orange; not fusible, but losing its colour in a strong heat. The balas ruby is so called from the word *balacchan*, the Persian name of Pegu. In hardness it is inferior to the oriental ruby. Specific gravity 3.6; primitive form, a regular octohedron: this is also the form in which it is commonly met with. It is said by Vauquelin to contain, alumine 82.47, magnesia 8.78, acid of chrome 6.18. Crystals and fragments of the spinell-ruby constitute more than nine-tenths of what is known in commerce by the name of *sand of Ceylon*. This sand is a collection of various precious stones separated from the sediment of the rivers of that island, by which they have been conveyed from the interior: but, as a selection of the most valuable has already been made in India, where they receive their first polish, crystals of the spinell of any remarkable size or beauty are rarely met with in the sand when it is imported into Europe. The spinell is met with in the same situation with the oriental ruby, and principally in Pegu and Ceylon. The spinell is sometimes of a yellow, and sometimes of a bluish colour: sometimes entirely colourless.

AQUAMARINE, *Gemma aqua-marina*.

Hard, pellucid, lamellar, pale sea-green; not fusible per se, breaking into trapezoidal fragments. Found in Brasil, India, Siberia, Saxony, and Bohemia, sometime amorphous, sometimes crystallized in equiangular six-sided prisms longitudinally striated: its longitudinal fracture rather conchoidal, its transverse fracture foliated. It decrepitates when heated, and is generally a little discoloured, but does not melt: becomes electric by friction, when one of its ends is attractive, the other repulsive. Specific gravity 3.5; contains flex 69, alumine 13, glucine 16, oxyd of iron 1, lime 5.

EUCLASE,

EUCLASE, *Gemma euclasis*.

Hard, pellucid, lamellar, green, in four-sided oblique prisms whose edges are variously truncate and whose faces are oblique. This substance has been so denominated by M. Haüy, in consequence of its remarkable fragility. It has the double refracting power to a very great degree. By the blowpipe it loses its transparency; and is afterwards fused into a white enamel. Specific gravity 3.06. Contains silica 36, alumina 19, glucine 15, oxyd of iron 3. Of all minerals this is most easily divisible into laminae. There is only one known variety in the form of the crystal of this substance: and this is very remarkable on account of the number of its sides; which, when the variety is perfect, amount to seventy-eight. It consists of a prism having fourteen sides, terminated at each extremity by a summit or pyramid of thirty-two sides. Found in Peru.

BERYLL, *Gemma beryllus*.

Hard, little different from aquamarine; of a blue-green colour, not altering its colour or fusible by heat, of a conchaceous texture, which is foliated when broken transversely, in six-sided prisms, which are usually longitudinally striate. Found in the mountains of Saxony, Siberia, &c. in quartz, granite, wolfram, and other matrices: its crystals are of various magnitude, sometimes diaphanous, sometimes pellucid, rarely solitary or in pairs, generally aggregate or fascicled: colour approaching to green or blue, rarely to yellow. Specific gravity from 2.25 to 2.782. Contains a very small proportion of alumina, lime, and iron.

CHRYSOBERYLL, *Gemma chrysoberyllus*.

Hard, pellucid, green, highly shining internally, of a conchaceous texture. Probably only a variety of the former. Found in Brasil and Ceylon, in round

masses about the size of a pea, or crystallized; the form of its crystals being a four-sided rectangular prism, the most common variety of which is an eight-sided prism terminated by six-sided summits. Colour yellowish-green, with a sparkling surface. Texture foliated, with the foliations parallel to the faces of the prism: causes double refraction: is infusible by the blowpipe. Specific gravity 3.7; contains alumine 71.5, silica 18, lime 6, oxyd of iron 1.5.

CHRYSOLEITE, *Gemma chrysolithus*.

Hardish, pellucid, lightish, of a green colour which vanishes in a strong heat, fusible by the blowpipe and sparkling when melted, of a conchoidal texture. Found in Brasil, Ceylon, Siberia, Transylvania, and Bohemia, in angular fragments, grains, and crystallized. Colour yellowish-green mixed with brown, or verging to olive-green: surface of a fine splintery or scaly appearance, but such of the crystals as have not been injured by friction have their broadest sides longitudinally striate; but, where the surface has not suffered by attrition, it has a considerable lustre: the regular shape of its crystals is a six-sided flattened prism, terminated in six-sided pyramids, and differs from rock crystal in having the pyramids more obtuse. Specific gravity 3.4; contains magnesia 43, silica 38, oxyd of iron 19.

The chrysolite of the moderns, the least hard of those stones called gems, being commonly of some shade of green, differs therefore, judging by its name, from the chrysolite of the ancients. That probably was either a deep-coloured variety of the oriental topaz, or the gem which we call the hyacinth. The native situation of the chrysolite is not ascertained. The chrysolites of commerce are principally imported from the Levant. They appear generally in the form of irregularly-worn fragments, with occasional traces of a quadrangular prismatic crystallization.

Bruce

Bruce mentions an Emerald Island in the Red Sea; but says that the green substance he there met with was scarcely harder than glass. May not this have been a chrysolite, and this island the Topaz Island mentioned by Pliny? Jewellers have created much confusion with respect to the identity of the chrysolite; having applied the term to many different substances, from a mere resemblance in colour.

EMERALD, *Gemma smaragdus*.

Hard, pellucid, lightish, grass-green, when heated to 120° of Wedgewood becomes blue, but recovers its green colour when cold, melting before the blow-pipe, of a conchoidal texture. Found in the mountains of Egypt and Ethiopia, in Peru, Russia, and the confines of Persia: colour from the perfect to the pale grass green. Crystals hexagonal prisms, either perfect or truncate on the angles and edges, terminating in truncated pyramids: texture foliated: fracture conchoidal: becomes electric by friction, but not by heat: causes a double refraction: melts into an opaque coloured mass at 150° of Wedgewood. Specific gravity to 2.7; contains silica 64.6, alumina 14, glucine 13, oxyd of chrome 3.5, lime 2.56, moisture or other volatile ingredient 2. This is the analysis more particularly of the emerald of Peru, from which it appears, that this emerald of Peru only differs essentially from the beryl by containing an oxyd of the metallic substance called chrome. It is supposed that the more lively hue of the emerald is owing to the peculiar nature of the metallic substance by which it is coloured.

Emeralds are said to have been found in Asia, particularly in Ceylon; and in Egypt: but it is doubtful whether a stone of the same species with the Peruvian emerald, that is, containing at the same time glucine and oxyd of chrome, was known before the discovery of America. Tavernier says that the emerald is an

occidental gem, imported from America to the Philippine islands, and from thence into Europe. That which is called the Oriental emerald, and which differs from the Peruvian not less in its superior degree of hardness than in the nature of its constituent parts, is a green variety of the sapphire; and of this nature probably is the gem of the late Archbishop of York, mentioned by the Dean of Westminster in his History of the Commerce and Navigation of the Ancients. This gem, engraved with a Medusa's head of Grecian sculpture, was brought from Benares. The table in the abbey of Reichenau near Constance, said to be of emerald, was ascertained by Mr. Coxe to be green flint of lime. The famous cup long preserved at Genoa under the name of *Sacra Catino*, and now in possession of the French, is upon good grounds considered as nothing more than green glass.

It is not easy to conjecture what was the nature of the *smaragdus* of the ancients: Pliny says that it possessed the most vivid of all green colours; and this probably might be said at his time of the oriental emerald: but it may be inferred from the following passage that the *smaragdus* was too commonly used, and its dimensions too large, to justify the supposition of its being that substance. Speaking of the *smaragdus* he says, '*Scalpentibus gemmas non alia gratior oculorum refectio est: ita viri dilectitate lassitudinem mulcent.*' The emerald is rarely of any considerable magnitude, and at the same time perfectly clear and free from spots. It possesses the same distinctive marks of character as the beryll. The resemblance between them induced Wallerius to class them under the same head before the correspondence in their physical and chemical characters had been ascertained. Werner however still considers them as distinct species.

The emerald is found in considerable abundance in Peru, between the mountains of New Grenada and of Popayan, in the clefts and cavities of schistose and granitic

granitic rocks. Count Bournon met with crystals of emerald in France, in a part of the same rock where he found sapphires. Brochant says that Dolomieu found a transparent and colourless emerald, in granite, in the isle of Elba.

GARNET, *Gemma granatus*.

Hard, ponderous, red, of unequal texture; preserving its colour in a low heat, melting in a stronger heat into a brown opaque spumid mass. There are about fifteen different varieties, distributed throughout Britain, Bohemia, and various parts of Europe, Madagascar, Ethiopia, India, Sirian in Pegu, &c. sometimes in mass, sometimes crystallized, in innumerable varieties of black, brown, purple, red, green, and yellow: texture foliated: fracture commonly conchoidal: lustre glassy and waxy. The colour most esteemed in the garnet is red: but it is met with of various other colours; yellow, green, brown, and black. Its specific gravity varies from 3.55 to 4.18. Primitive form, a dodecahedron with rhomboidal faces, all of which are similar and equal. This form, which corresponds with that of the cells in a bee-hive, comprehends the greatest capacity under the smallest extent of surface. The essentially-constituent parts of garnet are silice, alumine, lime, and oxyd of iron; but the proportions of these vary considerably: viz. silice from 34 to 52, alumine 6 to 28, lime 0 to 33, oxyd of iron 10 to 36; but the Sirianic and Bohemian garnet, which are most valuable on account of their transparency and colour, contain a greater proportion of iron than any of the other varieties: the yellow and black garnet, a greater proportion of lime, and a less proportion of alumine. It appears also, as indeed might be expected, that the specific gravity of garnets is heightened in proportion to the quantity of iron contained in them. The difference however in their analyses renders it doubtful, whether

whether these several substances can be considered as of the same species.

The Oriental or noble garnet, as it is also called, is said to be of a crimson colour; the Bohemian, rather of a blood red: but it should be observed that the term *oriental* has a reference rather to beauty and hardness, than to local situation. The Bohemian garnet would indeed by jewellers be called *oriental* in preference to any other; being of a greater degree of transparency: hence indeed it is most frequently used in jewellery. In some instances the colour is so intense, that, to facilitate the display of this, it is cut into a form somewhat resembling the cup of an acorn, but more flattened. The Bohemian garnet is found, together with hyacinths and sapphires, in alluvial districts, which appear to have been formed by the detritus of basaltic and serpentine mountains. Small Bohemian garnets, when pulverized, are sometimes used as emery. Garnets are met with in most parts of the world; principally in gneiss, and rocks of the magnesian genus. They are very common in the highlands of Scotland, and are disseminated in crystals through the substance of varieties of gneiss and granite. But some specimens from that quarter consist of small dodecahedral crystals, of a blackish red colour, and about the size of a pea, loosely cemented together by a dark-coloured substance bearing no proportion in quantity to the garnets themselves, which constitute more than nine tenths of the whole mass. Some remarkably large crystals of garnet are met with in the mountains that separate Stiria from Carinthia: they are incrustated with green talc. Equally large crystals are found in the Tyrol; but without this incrustation of talc. Some of these large crystals are of a dark reddish black colour, and capable of receiving a polish sufficiently fine to reflect the images of objects from their surface. In some parts of Germany, and Bohemia, common garnets are employed as a flux in the reduction of iron ore;

ore; a purpose to which they are particularly adapted, as they themselves contain a considerable proportion of iron. It is a remarkable fact, that in some instances the most perfectly transparent garnets affect the magnetic needle. The garnet, when of a dodecahedral form, may be distinguished from the hyacinth of the same form, by the angle under which its faces mutually incline to each other, which is in every instance 120° ; while in the hyacinth it is sometimes greater, and sometimes less. On the same principle it may also be distinguished from dodecahedral hornblende, and some of the varieties of staurolite. It may be distinguished from leucite, by its fusibility and greater specific gravity: from the ruby and spinell by its inferiority in colour and hardness, and by its fusibility.

There is a curious passage in Pliny, by which it appears that in his time imitations of the precious stones were commonly made in glass, with foil, or something analogous, placed under it: but that they might be detected by their want of hardness, and inferior specific gravity. He makes the observation in speaking of the difficulty of distinguishing real from artificial carbuncles, or garnets: "*Nec est aliud difficilius quam discernere hæc genera: tanta est in eis occasio artis, subditis per quæ translucere cogantur: adulterantur vitro, simillime; sed cote deprehenduntur, sicut aliæ gemmæ factitiæ, mollior enim natura: deprehenduntur et pondere, quod minus est vitreis.*" Nat. Hist. lib. xxxvii.

GLUCINA, GLUCINE.

WE place this newly-discovered earth here, because it was first discovered in the beryl, and has been met with only in the beryl, the emerald, and another mineral lately found in Peru. The salts which it forms with acids are highly saccharine; hence the name Glucine, from the Greek *γλυκύω*, to render sweet. Its
general

general properties are as follow : It is white ; insipid ; insoluble in water ; adhesive to the tongue ; infusible ; soluble in the fixed alkalis ; insoluble in ammoniac ; soluble in the carbonat of ammoniac ; soluble in almost every one of the acids (except the carbonic and phosphoric acids), and forming salts of a saccharine taste ; fusible with borax into a transparent glass ; absorbs one fourth of its weight of carbonic acid ; decomposes the aluminous salts ; is not precipitable by well-saturated hydro-sulphurets.

The specific characters of glucine, which are united in none of the other known earths, are : 1. Its salts are saccharine, and slightly astringent ; 2. It is very soluble in the sulphuric acid by excess ; 3. It decomposes the aluminous salts ; 4. It is soluble in the carbonat of ammoniac ; 5. Is completely precipitated from its solutions by ammoniac ; 6. Its affinity for the acids is intermediate between magnesia and alumine ; and its parts are not agglutinated by heat, as those of alumine are.

OLIVINUS, OLIVIN.

CONSISTING of the greater part flix, and a smaller proportion of alumine and oxyd of iron : found in basaltcs, shining internally, generally of a common form, hard, mouldering in the air : melting with difficulty.

Olivin is allied to Chrysolite. The term *olivin* is derived from its usual shade of colour. It occurs in grains or irregularly-spherical particles, in basaltic rocks : according to some, in no other situation. It is very liable to decomposition, first losing its lustre and then its consistence ; crumbling at length into a loose earthy powder of a yellowish-brown ochry colour. From a knowledge of this circumstance the porous appearance of some varieties of basalt may perhaps be accounted for ; the particles of olivin originally contained in them having been separated by gradual decomposition.

COMMON

COMMON OLIVIN, or OLIVE CHRYSOLITE,
O. Werneri.

Specific character, tinged, diaphanous, of a conchaceous texture, breaking into indeterminate fragments. Found in Arthur's Seat near Edinburgh, in France, Germany, and most parts of Europe, imbedded in basalt, sometimes in the form of grains, sometimes in large pieces: colour olive or yellowish-green, and when withered brownish or ochre-yellow: is attacked by digestion in nitric acid, and its ferruginous parts taken up. Specific gravity 3.225.

HYALITE, or MULLER'S GLASS, *O. vitreus.*

Pellucid, pure white, of a glassy texture: breaking into indeterminate fragments, with the surfaces spherically convex. Found in Germany, Hanover, and Frankfort, in rocks of trap or serpentine, and occurs in the form of grains, filaments, or rhomboidal masses: texture foliated: fracture inclining to rhomboidal: is generally transparent, sometimes, though seldom, opaque: is infusible at 150° of Wedgewood, but yields to soda. Specific gravity 2.11, contains silica 57, alumina 18, lime 15, and a very little iron.

FELDSPATHUM, FELSPAR.

CONSISTING of the greater part silica, some alumina and potash, and a very small quantity of lime and oxyd of iron: hard, lightish, shining, lamellar, breaking into fragments which present four faces, mouldering into argil, parasitical: not effervescing with nitric acid; easily melting, without ebullition, into a pellucid glass.

Felspar signifies *Rock-spar*, from the German word *fels*, a rock. By some it is called Feldspar or Field-spar, from the German word *feld*, a field; crystals of it being often found dispersed over open tracts of country. It is sufficiently hard to scratch glass, and

strike fire with steel. Phosphorescent, and electric (though not easily) by friction. It has a double refracting power. Specific gravity varies from 2.4 to 2.7. Primitive form, an irregular obliquely-angled parallelopiped. It occurs both crystallized and amorphous. Sometimes uninterrupted masses of felspar are met with in the form of rocks or mountains; but most commonly it is a constituent part of other rocks, particularly granite and porphyry.

Felspar is often remarkably disposed to undergo a spontaneous disintegration; which there is reason to suppose, in some instances at least, depends on a previous alteration in the nature or proportions of its component principles. This alteration is thought by Werner to have been effected by the loss, either partial or entire, of the potash naturally contained in it. And this opinion is supported by the observation that felspar is, often, less fusible in proportion to its state of disintegration; and that those felspars in which a considerable proportion of potash is present are very fusible. Some have thought that the disintegration depends on exposure to the atmosphere: but Mr. Jameson observed, at great depths in the mines of Freyberg, beds of gneiss completely sheltered from the action of the weather, in which the felspar was entirely disintegrated. Perhaps this altered state of felspar may be referred, as Mr. Davy has suggested with respect to the spontaneous alteration of mineral substances in general, to the agency of electricity.

The felspar of the white granite in many parts of Cornwall occurs in a completely disintegrated state. Here and there indeed the process has not advanced sufficiently far to destroy the cohesion of the particles of the felspar, though its substance is so far softened as easily to yield to the knife like steatite: but upon the whole it is in a loose earthy state. In the neighbourhood of St. Austle there is a tin mine, or rather quarry; in which the different stages of this process may be traced

traced very satisfactorily. The altered state of the felspar renders the granite of this quarry so friable that it is very easily removed; and hence the veins of tin ore by which it is intersected are not followed in the usual manner by means of shafts and levels; but the granite is quarried like free-stone, and the ore is separated by the process of stamping and washing. In some parts of the quarry the disintegrated felspar occurs in distinct patches, and may be easily detached without any particles of the quartz; with which it is in general intimately mixed: but at all times it may be separated by simply stamping the granite, and diffusing it through water. The particles of tin ore and of quartz very soon subside, in consequence of their greater bulk or specific gravity; and the supernatant water, together with the felspar suspended in it, is drawn off and conveyed to pits, &c. excavated for the purpose. By degrees the felspar subsides; and, the water being again drawn off, a white sediment is left of the consistence of paste: if this be dried it contracts into a soft earthy mass of a very white colour, and in appearance and general characters closely resembles a very pure natural clay. This process is analogous to that by which whiting is prepared from chalk. The felspar thus separated is extensively employed in the manufacture of porcelain.

CUBIC FELSPAR, OR PETRILITE, *F. cubicum*.

Reddish-brown, of a glassy lustre, and somewhat splintery fracture, breaking into cubic fragments which are not specular, falling spontaneously into crustose fragments. Found, though rarely, in Saxony, of a common form, diaphanous or somewhat opaque: fragments cubic or inclining to that form, the faces of which are not polished: is very brittle, and at 160° of heat whitens and concretes without any farther sign of fusion.

COMMON FELSPAR, *F. vulgare*.

Of a glassy lustre and foliated texture, breaking into rhomboidal fragments with four specular faces. There are many varieties, differing chiefly in the form of the crystals. Common felspar is found every where in primitive mountains, forming a part of granite, porphyry, and gneiss, rocks; compact, solid, and incorporated with other substances; and generally moulders into a kind of porcelane clay: colour generally flesh-colour, bluish-grey, yellowish-white, milk-white, or brownish-yellow, rarely blue or olive-green, very rarely black: texture in straight shining foliations, cross fracture uneven: when heated, the crystallized kind often decrepitates: it is less hard than quartz, but strikes fire with steel.

LABADORE FELSPAR, *F. variabile*.

Of a vivacious lustre, reflecting various colours in certain positions of light, of a foliated texture, breaking into rhomboidal fragments with four specular faces. Found on the Labradore coast, the Island St. Paul, and in various parts of America and Europe, in round masses and detached, and often containing thorl, mica, and pyrites. It is called *opaline* felspar from a remarkable play of colours, visible, as it were in its interior, when held in particular directions: the most conspicuous colours are blue, green, purple, and orange-red; the intensity of these altering according to the alteration of the direction in which the stone is held.

PURE FELSPAR, OR MOONSTONE, *F. lunare*.

Pellucid, white, of a high lustre, and straight lamellar texture, breaking into rhomboidal fragments. Found in Ceylon and Swisserland, Bohemia and Saxony, in solid masses and also crystallized; the crystals rhomboidal, of irregular angular broad six-sided columns

lums terminating in pyramids and in rectangular four-sided plates: colour white, with sometimes a shade of yellow, green, or red, the surface often reflecting iridescent colours: the fragments often appear striated. This species is sometimes called *Adularia*, from *Adula*, an old name of one of the heights of St. Gothard; where it was discovered in the fissures of rocks of gneiss and micaceous schistus. It is called *moon-stone* from its colour and soft lustre.

CAT'S EYE, *F. oculus cati*.

Diaphanous, of an imperfectly-foliated texture, exhibiting parallel fibres internally, breaking into somewhat irregular fragments. Found in Ceylon and Siberia, of a nearly square figure, with sharp edges and a good deal of brilliancy: colour grey, with a tinge of green, yellow, or white; in certain positions reflecting a splendid white like the eye of a cat; sometimes brown with a yellow or red tinge: its texture is so compact, that the foliations are hardly discernible, and is so hard as to strike fire with steel.

PYROMACHUS, FLINT.

CONSISTING principally of flint, with a very small portion of alumine and oxyd of iron, and frequently a little carbonat of lime: hard, semitransparent, lightish, of a conchoidal texture, breaking into indeterminate very acutangled fragments, rarely separating into concentrically crustose fragments, with hardly any lustre, found chiefly in stratarial mountains, and rarely forming strata itself: not fusible per se before the blowpipe. There are five species, of which we shall only describe

COMMON BLACK FLINT, *P. cretaceus*.

Tinged, semitransparent, of a perfectly conchoidal texture. Found in Britain, France, Denmark, and other European countries: colour varying from honey-

honey-yellow to brownish-black, with variations often in the same specimen in the form of veins, stripes, clouds, or dots. When two pieces are rubbed smartly together, they phosphoresce and emit a peculiar odour: when heated it decrepitates, and becomes white and opaque. Specific gravity 2.630. Contains silice 98, lime 0.5, alumine 0.25, oxyd of iron 0.25, water 1. Flint, then, as appears by the foregoing analysis, is nearly a pure natural form of silice. In this country it occurs either in thin strata disposed horizontally in chalk; or in loose beds of a coarse gravel. In the former instance, it is in the mass of a dark grey or nearly black colour; when in thin fragments, of a light grey with a considerable degree of transparency: reduced to powder, it is nearly white. Externally it has a superficial coating of an opaque white colour; but it does not seem clearly ascertained of what nature this substance is: whether a particular state of chalk in its passage into flint, or an altered state of the flint itself. By exposure to the changes of the weather, flint loses its black colour, and becomes ochry; probably in consequence of the farther oxydation of the iron originally contained in it: and hence the colour of those beds of gravel met with in the vicinity of London, and all those districts where strata of chalk occur; these beds being principally made up of fragments of the common black flint, altered by exposure to the air, &c. Entrochi and varieties of the echinus occur in a fossil state imbedded in flint; the substance of those fossil bodies being at the same time of a flinty nature: sometimes the shell of the echinus is calcareous, but so far changed from the animal state as to be of a sparry structure; and in these cases the cavity is filled with flint. Hollow nodules of flint occur occasionally, partly filled with a white crumbling substance, resembling chalk in its appearance; but not always effervescing with an acid. Sometimes the cavity of these nodules has a blistered surface, as if the flinty matter

matter had been deposited stalactitically: in this case the appearance of the blistered part is very like calcedony. Pear-shaped masses of flint are sometimes met with, bearing no mark of an organic origin with the exception of their shape: and in some instances these are penetrated in various directions by tubular cavities somewhat resembling the cavities formed in limestone by the pholas. The flint of the chalk strata in the neighbourhood of Wantage has often a flattened form; and consists of two plates attached to each other imperfectly, much after the manner of the outer and inner plates of the thick bones of the human cranium. In some instances it has an irregularly-stratified appearance; and is frequently of a light grey colour. Mr. Kirwan says that one hundred and twenty-six silver coins have been found inclosed in flint, in Denmark; as also an iron nail, at Potsdam.

Two very opposite opinions are entertained at the present day respecting the origin of flint as it occurs in strata of chalk: one, that it has been deposited there by aqueous infiltration of the siliceous particles; the other, that it has been forcibly injected while in an ignited and liquid state between the strata of the chalk. Werner's idea is, that during the deposition of chalk, air was evolved; which, in endeavouring to escape, formed irregular cavities that were afterwards filled up, by infiltration, with flinty particles. Mr. Kirwan entertains the same idea respecting the infiltration of flint; and in support of his opinion observes that chalk is constantly found to contain more or less of minute siliceous particles.

PETROSILEX, ROCK-FLINT, or CHERT.

CONSISTING of the greater part siliceous, about twenty-two per cent. alumine, and six per cent. carbonate of lime: hardish, lightish; found in primeval and stratified mountains, without lustre, breaking into indeterminate

minate fragments, of a splintery texture: melting before the blowpipe. There are three species.

CHERT, OR HORNSTONE, *P. opacus*.

Nearly opaque, of a common form. Chert is properly a species of flint, which occurs in irregular veins and patches in the substance of common limestone; and is often not sufficiently defined in its character to be recognized at once by the eye from the limestone containing it. From being incorporated with the substance of the rock containing it, and never occurring in distinct nodules, like the common black flint, it has been called *petroflex*, or rock-flint. The chert met with in the limestone of Derbyshire is often of a light bluish grey colour: sometimes it is of a jet black. Chert has been called a not-yet-matured agate, and its occasional appearance justifies the term; though perhaps it may with more propriety be classed as an imperfect calcedony. There are four varieties, which are found in Sweden and Germany, forming veins and beds of mountains. Colour usually blue-grey, sometimes grey, blue, and green of various shades. By breathing on it, it discovers an earthy smell, and is sometimes so hard as to strike fire with steel: it decomposes sooner than flint, and does not take so high a polish: in the fire it decrepitates and whitens.

JASPIS, JASPER.

CONSISTING of flex, a smaller proportion of alumine, and a small quantity of oxyd of iron, with generally a little magnesia and potash: hardish, opaque, breaking into indeterminate fragments, of a conchoidal texture, lightish, sometimes detached, sometimes a principal ingredient of ancient mountains, of a common form: losing its colour in the fire.

EGYPTIAN PEBBLE, *J. Egyptia*.

Of a dull colour, varied with differently-coloured concentric

concentric stripes or layers, and black dendritical figures. Found near Suez in Egypt, and sometimes in Hungary and Lorraine, generally in longish oval flat-tish pebbles, and enveloped in a coarse rough crust: colour a liver-brown, glittering when broken, the fragments irregularly angular and opaque, and taking a fine polish: the concentric stripes or layers are various shades of yellow, reddish, green, or white, but the dots and dendritical figures are always black: fracture conchoidal: when heated it does not decrepitate. Specific gravity 2.6. It is made into vases, snuff-boxes, and other ornaments.

STRIPED OR RIBBAND JASPER, *J. fasciata*.

In differently-coloured alternate parallel layers, without lustre internally, of an imperfectly conchoidal texture. Found in Siberia, in Saxony near Gnantstein and Wolfütz, and particularly fine at Ural, in large amorphous masses forming long layers: colours yellowish, greenish-grey, ochraceous, isabella yellow, brownish-red, pale or dark flesh-red, mountain or dark green, generally disposed in parallel layers which are commonly straight, rarely curved, seldomer in oblong spots. When broken it exhibits a dull imperfectly-conchoidal surface, and is sometimes semi-transparent on the edges. It takes a high polish.

PORCELLANE JASPER, *J. porcellana*.

Hard, rifted internally, of an imperfectly-conchoidal fracture. This species is found in large compact layers, and frequently between the fissures of basaltes, in Bohemia and Saxony; has an arid appearance when broken, like dried clay, and is full of cracks or flits; and is supposed to have been altered by the action of fire.

COMMON JASPER, *J. vulgaris*.

Hardish, shining or polished internally, of one uniform

form colour, or veined or spotted. Found in Germany, Saxony, Silesia, Hungary, &c. in large compact masses, sometimes coarsely interspersed in alternate layers with other stones, and often in obtuse angular pieces: colours different shades of black, white, yellow, red, brown, and green; often variegated, spotted, or veined, with several colours: is frequently enriched with iron and gold ores, and admits a fine polish: fracture conchoidal, or sometimes imperfectly foliated. Specific gravity from 2.53, to 2.70.

Wood Jasper. This variety is so called from its general appearance, which often very accurately resembles petrified wood. In some cases this appearance is the result of the original formation of the substance: in others it seems to have arisen from the actual deposition of siliceous in the place of vegetable matter. The following distinctive mark has been given by which to ascertain the real origin of this jasper. In petrified wood not only the concentric circles of the original vegetable are present, but also the vessels or fibres which extend from the centre towards the circumference. The smooth Turkey hone-stone is made of this variety of jasper, which is found in Bohemia, Hungary, &c. and in Siberia: but the matrix of it is not known. Masses closely resembling trunks and branches of trees occur in great abundance dispersed over the sandy districts of the northern part of Africa.

LAZULUS, LAPIS LAZULI.

CONSISTING of silice, with a less proportion of alumine and carbonat of lime, and a small quantity of sulphat of lime and oxyd of iron: opaque, hardish, blue, dense, without internal lustre, breaking into indeterminate fragments, producing a white powder when pounded: neither losing its colour nor effervescing from acids sprinkled on it, melting easily in the fire into a frothy slag. There is but one species, called

Lazulus Orientalis, the *Cuprum lazuli* of Linnaeus.

It is found on the confines of Siberia, Tartary, and China, generally in solid masses, and usually full of veins of quartz, limestone, and pyrites: colour sky-blue, often with white or yellow spots or veins: if calcined, it effervesces a little with acids, and forms with them a gelatinous mass: it retains its colour a long time in the fire, but at last becomes brown: when boiled in concentrated vitriolic acid, it dissolves slowly, and loses its colour. Specific gravity from 2.76 to 2.94: contains silica 46, alumina 14.5, carbonate of lime 28, sulphate of lime 6.5, oxide of iron 3, water 2. It is the *pierre d'azur* of Brochant and other mineralogists, from its blue colour; but, according to Haiiy, the Arabians call this mineral by the name of *azul*; and hence the term *lazuli*. The blue colour of lapis lazuli was formerly supposed by most mineralogists to be owing to the presence of copper; of which however not the least particle is contained, as appears by the foregoing analysis. Wallerius thought that it was coloured by silver; but this is also a mistake. Lapis lazuli frequently contains iron pyrites, disseminated through its substance in specks and veins. It has not yet been found crystallized. In the mass, this substance is used for ornamental purposes; when separated from the matrix in the state of powder, it is used as a pigment, and is called *ultramarine*: Baccius says it is probably so called because it exceeds the colour of the sea; but this etymology seems fanciful: perhaps it was so called in consequence of its being imported into Europe from beyond sea; for according to Jameson it has not been met with in Europe except among the ruins of Rome. The colour is prepared by calcining the mineral, pounding, and washing it; and collecting the sediment.

Tavernier says that it is found near Thibet. According to Mr. Kirwan it is found only on the confines of Siberia and Tartary, or China; and lately, as is reported, in America. It was called *Cuprum lazuli* by

Linnæus; but is distinguished from blue copper ore by retaining its colour in an ordinary heat. Gmelin calls it *Lazurus*, and places among the Calcareous Earths; Dr. Turton has removed it.

SMIRIS, EMERY.

CONSISTING of alumine, filex, and a large quantity of iron: very hard, of a common form, opaque, attracted by the magnet, red when powdered: not fusible per se. There is but one species, called *Smiris poliens*. Found at Guernsey, and in Germany, Italy, Spain, and in the islands of the Archipelago; but is usually imported from the isle of Naxos, always in shapeless masses, and mixed with other minerals. Colour greyish-black; when reduced to powder, reddish-grey: has a granular texture, and is so hard as to cut all stones except the diamond, upon which account it is principally used in powder for polishing metals. In the working of gems, and it is even employed in cutting the hardest of them, as the sapphire and ruby, emery is mixed with water: in the working of metals, it is mixed with oil; probably to prevent their rusting.

CIRCONIUS, ZIRCON, or JARGON.

CONSISTING of filex, a more than double proportion of circonia, and a very small quantity of metallic oxyd, partly of iron, partly of nickel: very hard, ponderous, imitating the diamond in its lustre, parasitical, foliated with the foliations incurved, crystallized: not fusible per se.

Circonius Zeylanicus, called also *mock-diamond*, is the only species; found in Ceylon, in small irregular grains, or crystallized in four-sided rectangular prisms terminated each side by a four-sided pyramid, or in double four-sided pyramids. Colour grey, greenish, yellowish-brown, reddish-brown or violet: strongly semitransparent, sometimes opaque: scratches glass, and
is

is not altered by the heat in which the diamond is consumed. Specific gravity 4.416; contains circonius 68, filex 31.5, nickel and iron 0.5. This earth is found in one other substance only, viz. the hyacinth, p. 423.

AMARUS, BITTER EARTH.

CONSISTING of filex, a smaller proportion of magnesia, a very small quantity of alumine and carbonat of lime, and ten per cent. of oxyd of iron: hard, tenacious, subopaque, a little greasy, green, of a splintery texture, breaking into indeterminate fragments, of a common form: not fusible per se.

Amarus Amazonicus, the only species, is found in the East, New Zealand, and the Helvetic and Subau-dic mountains, sometimes detached, sometimes forming vast masses: colour green with a cast of blue, and in the prominent point of the fragments inclining to milk-white. By the inhabitants of the East and New Zealand it is fashioned into various ornaments, vessels, and arms.

LYDIUS, LYDIAN STONE.

CONSISTING of filex, a small quantity of lime, magnesia, oxyd of iron and inflammable matter: hard, lightish, opaque, compact, cinereous, black or greenish-black, flaty, of a common form, breaking into indeterminate fragments, detached or constituting mountains: not fusible per se.

SILICEOUS LYDIAN STONE, *L. siliceus*.

Subopaque, of a splintery fracture, without internal lustre. Found in various parts of Europe, in blocks and amorphous masses of various sizes, and very often in the beds of rivers: colour blackish-grey or greenish, often intersected with veins of grey quartz or blood-red iron-stone. This is a variety of primitive schistus, the structure of which is so compact that the schistose

schistose character is often not distinctly perceptible, except in great masses: its texture in particular parts is as close as flint: and hence the term *siliceous schistus* is applied to it.

GENUINE LYDIAN STONE, BASANITE, OR TOUCH-STONE, *L. genuinus*.

Of an even texture, sometimes approaching to the conchoidal, shining a little internally. Found in the river Tmolus in Lydia, and in various parts of Europe, detached or in masses, and is commonly intersected by veins of quartz: colour dark greyish-black; its powder black. Specific gravity 2.596. It is called *basanite* from its occasional use in assaying the purity of gold and silver. The use of the *touch-stone* for the purpose of ascertaining the degree of purity of gold and silver is spoken of frequently in the writings of the ancients. Theophrastus gives an accurate description of its use; and describes an apparatus very analogous to the touching-needles of the present day; by which, in employing various artificial alloys as a standard of comparison, the purity of gold was readily ascertained by the colour of the streak impressed on the stone. Black compact basalts, and even dark coloured limestones, are often used as touch-stones.

CHLOROGRANATUS, GREEN EARTH.

CONSISTING of *filex*, a large proportion of oxyd of iron and carbonat of lime, with frequently alumine: hard, never opaque or subopaque, crystallized: easily fusible in the fire. There are two species.

TRUE GREEN EARTH, *Chl. verus*.

Green, becoming honey-yellow in a white heat. This occurs in double eight-sided pyramids, augmented at each point by another three-sided pyramid; but sometimes in six-sided prisms, terminating each side in

a three-sided pyramid. Both varieties are found in Bohemia, Saxony, and Franconia. Colour from leek to olive-green, sometimes diaphanous, sometimes pellucid, and often forms entire strata with layers of clay: frequently contains a fourth part of iron, and is used as a flux in iron-furnaces. Specific gravity 375.

The other species, *Chl. dubius*, may probably not belong to this genus.

ARENA, SAND.

GENERIC characters, Consisting of comminuted siliceous stones: rough, hard, dry, in minute distinct granulations, not penetrable by water: not fusible per se, but melting with soda into glass.

I. *Originating from comminuted Flint-stones.*

SILICEOUS SAND, *Arena silicea*.

Composed of fragments of flint. The only species in this division. It is found in Buckinghamshire and other places.

II. *Composed of comminuted quartz.*

GRAVEL, *Arena sabulum*.

Consisting of angular unequal large grains. Found every where on barren rocky mountains, and is produced by granite which has mouldered from exposure to the air; it is frequently found mixed with particles of mica, felspar, and argil.

WRITING SAND, *Arena micacea*.

Shining with numerous interspersed small scales of mica, resembling thin plates of gold or silver in colour and lustre. Found in Sweden and Germany, and in the island Casserita; and is composed of comminuted granite, and other like stones. It is the sand used to dry up the ink on newly-written letters.

COMMON

COMMON SAND, *Arena rustica*.

Consisting of roundish unequal larger grains. Found every where in Europe, principally upon shores, and contains some lamellar particles apparently of quartz.

DUST SAND, or GRIT, *Arena glareæ*.

In very minute grains mixed with pulverised alumine. Found on barren commons and heaths: is very easily blown about when dry, but when wet is rather plastic and yields to the pressure of the hand. It is chiefly used in the beds and moulds where metals are cast.

QUICKSAND, *Arena mobilis*.

In very minute round transparent white grains. Found in the sea and adjacent wastes, and is also thrown out from springs: when dry it is so light as to be driven about by the winds and collected into sand-banks, and often taken up in vast masses by whirlwinds, overwhelming and suffocating travellers and even whole villages: it is kept compact by the roots of the *Elymus arenarius*, *Arundo arvensis*, *Triticum repens*, and some species of willow.

QUARTZUM, QUARTZ.

CONSISTING of flint, about six per cent. of alumine, and one of carbonate of lime: hard, lightish, brittle, shining internally, breaking into indeterminate fragments with acute margins, more commonly parafitical, found in mountains of all ages, mouldering in the air: not melting by fire alone, but with soda running into a hard pellucid glass. It is sufficiently hard to scratch glass, and strike fire with steel; but yields to the file; has a double refracting power, is phosphorescent by friction, with a peculiar empyreumatic smell.

Quartz, whether distinctly crystallized or not, for the most part occurs in veins; though these are sometimes

sometimes so large as to assume the appearance of mountainous masses. It has in general a vitreous appearance when broken; and this is sometimes joined with an unctuous lustre that has given rise to the terms *Quartzum pingue*, *Quartz gras*, &c. The common form of quartz crystals is, when completed, a six-sided prism; terminated at each extremity by a six-sided pyramid: but as the crystals frequently project from the matrix containing them, so as only to exhibit a part of the prism with the pyramid attached to it, double pyramidal crystals with an intervening prism do not often occur. Where they do occur, they are either simply aggregated, as in some of the varieties of the mineral called *finople*; or entirely imbedded in the matrix containing them, as in decaying granite and other rocks. The surfaces of the prism are often transversely striated, while those of the pyramid are to the eye perfectly smooth. In general the length of the prism is greater considerably than that of the pyramid. In some instances the prism is so shortened, as to be scarcely perceptible; and then the form resembles that of two six-sided pyramids, joined base to base: but it very rarely happens that the prism is absolutely wanting, though the eye cannot discover it. Crystals approaching to this form, and of a very remarkable degree of transparency, occur in the ironstone found near Bristol: they are called Bristol diamonds.

Although the greater number of quartz crystals are varieties of the form above described, yet from the mutual disproportion of the different sides of the prism and pyramid, the resemblance is often so much obscured, that the real form cannot easily be traced. Sometimes two opposite sides of the prism are so much broader than the other four, as to give the crystal a tabular form: sometimes the area of one of the sides of the pyramid is larger than that of the other five taken together; and the area of the side immediately

adjoining is not only the smallest of all, but so small as to be scarcely perceptible. In some instances the faces of the pyramids are alternately large and small: in which case the large faces are pentagons; the small faces, triangles. But in all these variations arising from a difference in the size and form of the surfaces, the mutual inclination of the sides of the prism constantly takes place under the same angle. Crystallized quartz does not easily admit of mechanical division; but accidental fractures sometimes exhibit in a very distinct manner the direction of the crystalline laminæ. There are twenty-four species, of which the following are the chief.

FIBROUS QUARTZ, *Qu. fibrosum*.

Diaphanous, whitish, fibrous, with the fibres thicker and parallel; of a common form. Found on the Carpathian mountains in Hungary, and near Rabischau in Silesia; exceeding rare.

CELLULAR QUARTZ, *Qu. cellulosum*.

Lamellar, with the plates contiguous, placed at various angles with each other and forming cells, of a common form. There are seven varieties, differing in the form of the cells. Found in Siberia near Catharinopolis, in Hungary near Chemnitz and Neosolium, in Bohemia near Joachimsthal, in Saxony near Schneeberg and Freyburg, and in the Palatinate: colour sometimes white, sometimes more or less tinged with oxyd of iron.

LAMELLAR QUARTZ, *Qu. lamellosum*.

Lamellar, with the plates parallel, of a common form. Found near Chemnitz in Hungary, and in the mines of Bohemia: colour milk-white, white, violet, or brown: rarely yellow and blue: the foliations are sometimes very thin, and compacted together.

GRANULAR

GRANULAR QUARTZ, *Qu. granulare.*

Separating into granular fragments. Found commonly in small grains, sometimes detached, sometimes compacted together, in Norway, Spain, France, and Saxony: colour white, variegated, greenish, red, or yellow-brown: the grains are sometimes so disposed as to reflect a fine splendour when polished.

STALACTITIC QUARTZ, *Qu. stalactitum.*

Gradually deposited by water impregnated with particles of quartz, and often covering other bodies as with a bark. Found at Breiback on the Hacksburg in the bishopric of Cologne, in Iceland, Sweden, and Hungary: colour diaphanous, generally white, sometimes yellowish or reddish; and appearing in the form of solid or hollow cones, or in that of roses, cauliflowers, grapes, &c.

PRASE, OR PELLUCID QUARTZ, *Qu. prasus.*

Leek-green, diaphanous, of a coarse splintery texture. Found at Schwartzenburg in Saxony, in Finland, Siberia, and Bohemia; either in irregular masses, or crystallized in six-sided pyramids, or in small six-sided tables superimposed one on the other, sometimes in slender needle-like crystals: colour green of various degrees of density, whence the name; sometimes yellowish or bluish green: when broken it is shining, and of a coarse shivery texture, sometimes approaching to the imperfectly-small conchoidal: admits a degree of polish, and is frequently numbered among the gems.

COMMON QUARTZ, *Qu. pingue.*

Of a common form, slightly greasy to the touch, approaching to the minutely-conchoidal texture, not falling spontaneously into fragments. The three varieties are, 1. pellucid; 2. diaphanous; 3. coloured.

They are all found distributed in most parts of the globe, frequently in the native oxyds of metals and minerals, sometimes forming whole rocks, and sometimes in beds and veins; of various degrees of transparency and colour, but generally white or greyish.

BRISTOL DIAMOND, *Qu. pseudadamus*.

Of a conchoidal texture, in a double six-sided pyramid, not striate. There are seven varieties; they are found near Bristol and Buxton, in Cornwall, Derbyshire, and Northumberland, and various parts of Europe: colour mostly white, sometimes reddish or blackish; rarely hollow within: the crystals sometimes detached, sometimes clustered and adhering together in various forms.

COLOURLESS QUARTZ, OR ROCK-CRYSTAL, *Qu. crystallus*.

White, pellucid, of a conchoidal texture, in a six-sided transversely-striate prism. There are thirty-five varieties, some or other of which are found in almost every part of the globe, particularly in alpine situations, and almost exclusively confined to primitive rocks, especially granite and mica slate. Colour various shades of white, brown, red, and yellow, sometimes mixed together: fragments indeterminately angular, with very sharp edges: does not lose its transparency in the fire: causes double refraction. Contains silica 93, alumina 6, lime 1, according to Bergman: but, if the authority of Bergman may be questioned, says Dr. Kidd, the proportion of silica is probably greater than here stated: perhaps indeed colourless quartz is altogether of a siliceous nature; for even the common black flint contains ninety-eight parts in one hundred of silica: and it may reasonably be supposed, from all its characters, that colourless quartz is a purer natural form of silica than common flint.

Perfectly transparent and colourless quartz resembles

bles glass very closely: but the bubbles and fissures, which often occur in both, afford an easy method of distinguishing them; the bubbles being irregularly diffused, and nearly of a spherical shape, in glass; but, in quartz, disposed on the same plane or on parallel planes: and, generally, in the form of clouded specks. The iridescent appearance often visible in the interior of quartz depends on the refraction of light, in consequence of fissures either naturally or artificially formed. The Iris of Pliny is perhaps a variety of this kind; for he says, in speaking of it, "*sexangulam esse ut crystallum constat.*" The appearance may be artificially produced, by heating quartz nearly red-hot and then plunging it into cold water. By this means internal fractures are formed; and, if the quartz be dipped into a coloured liquid, which is sometimes done for the purpose of sale, the colouring matter is absorbed between the rifts. Quartz crystals are sometimes superficially iridescent; but this depends on a very thin incrustation of a metallic nature. Colourless quartz occurs commonly in the cavities of primitive rocks, especially granite and micaceous schistus. It is sometimes met with in the cavities of granular marble. Some of the most beautiful specimens come from Madagascar; from Mont Blanc; and from Dauphiny. Crystals of colourless quartz occasionally contain cavities which are partially filled with water: the air-bubble, or the space unoccupied by the water, is visible in moving the crystal in various directions. If the opposite surface of that part of a crystal which adheres to the matrix be polished, an appearance may be sometimes observed in the interior, resembling scales of mica as it were interposed between the crystal and the base on which it rests: this appearance probably depends on small fissures of a flat conchoidal shape.

AMETHYSTINE QUARTZ, *Qu. amethystinus*.

Violet blue, varying in texture, form, and degree of transparency. According to Pliny, the amethysts of the ancients were "omnes violaceo colore, et scalp-turis faciles:" the latter part of the description is more applicable to fluor spar than quartz. The amethyst of commerce is in most instances this species of quartz: when jewellers apply the term to the purple variety of the sapphire, they add the epithet *oriental*. Amethystine quartz occurs in different parts of Europe; and in Mexico and Ceylon; either in veins, or lining the interior of spherical and kidney-shaped agate balls, which are met with in porphyry and amygdaloid. Sometimes it forms a crystallized incrustation round a nucleus of a different nature. In the generality of instances the pyramid is the only part of the crystal that is visible; and, upon making a transverse section of these crystallized masses, it appears that they have been formed by successive depositions of pyramidal crystals; some of which are of a very pale, others of a deep violet, colour: the form of the pyramidal crystallization being easily traced by numerous acutely waving lines, or bands; the directions of which are parallel with each other, and with the outline of the exterior crystals. There is no regular gradation in the colours of these bands; and, not unfrequently, those which are nearest in situation are most different in colour. The surfaces of the exterior crystals are sometimes of a red or a brownish-red colour: sometimes they have a corroded appearance; and, in particular instances, the superficial cavities, from whence this corroded appearance proceeds, are filled with small micaceous tufts, or acicular particles of an imperfectly metallic lustre, of specular iron-ore, and manganese. There is a series of specimens of this kind in the Oxford collection, brought from the north of Europe, which evidently seem to prove that all the foregoing appearances

appearances are connected with each other: and that the red or brownish-red incrustation, observable on the surface of some of the crystals, is a more highly oxydated state of these metallic substances, which in a less oxydated state occupy the corroded cavities of other crystals. The mountains of Murcia contain great abundance of amethystine quartz. It contains filix 97·5, alumine 0·25, oxyd of iron with a trace of manganese 0·5.

CHALCEDONIUS, CHACEDONY, &c.

CONSISTING of filix, a small quantity of alumine, with sometimes about a tenth of lime, and a slight trace of oxyd of iron: hard, lightish, shining within, breaking into indeterminate fragments with sharp edges, compact, not mouldering in the air, of a more or less perfectly conchoidal texture, never opaque, tough, admitting a high polish, and generally of a common form: not melting before the blowpipe.

WHITE CHALCEDONY, or CACHOLONY, *Ch. cacholoni*.

Milk-white, somewhat diaphanous, becoming opaque in the fire. Found in the rivers of Bucharest and Mongool, and the Feroe islands, where it lies between the strata of semitransparent chalcedony. It is never found in drops or stalactitical. The Calmucs make their idols and domestic vessels of it.

GENUINE CHALCEDONY, *Ch. genuinus*.

Grey, of a flat texture and common form, not falling spontaneously into fragments. The name Chalcedony is derived from Chalcedon in Bithynia, the place where it is said to have been originally found. It is met with also in Cornwall, and the islands of Scotland, in Iceland, Silesia, the Feroe islands, Saxony, and Siberia, in various shapes, kidney-shaped, stalactitical, globular, botryoidal, like hollow pebbles, often containing

containing air-bubbles or drops of water; also in angular pieces and veins in porphyry and amygdalite, and sometimes cubic: colour various shades of grey, with sometimes a tinge of green or blue: lustre generally semi-transparent, rarely diaphanous: the surface is rough; fracture perfectly even, though sometimes passing into the fine splintery or imperfectly conchoidal. Contains silic 84, alumine mixed with iron 16.

Almost all the appearances of calcedony justify the idea that it has been formed by stalagmitic deposition; particularly the blistered or mamillated appearance so commonly observable on its surface. A very singular stalagmitic form of calcedony occurred some years since in one of the Cornish mines: it is nearly opaque and colourless; and, from its close resemblance to an agglutinated mass of the cylindrical bones of small birds, it has been denominated *skeleton calcedony*. But although calcedony appears to have been separated from water in as great a state of purity as any mineral, and often to have been placed under circumstances as favourable as possible to crystallization, it never shows the least tendency to an internal crystalline arrangement of its particles: its fracture is always perfectly compact. Crystals, indeed, the substance of which is calcedony, are often met with; but they are always pseudomorphous; and very frequently they are not solid, which is a strong argument in favour of their stalagmitic origin. Their surface is rarely smooth. The derivation of calcedony from the common black flint may be traced by very delicate gradations, and sometimes in the same specimen: for, upon breaking a nodule of the flint, a cavity is not unfrequently discovered, the surface of which consists of irregularly-blistered calcedony; the substance of the flint insensibly passing into that of calcedony. Calcedony is frequently contained in rocks of the basaltic genus, in nodular masses. These masses, which are in general of a light bluish grey colour, are often hollow, and set with amethystine quartz crystals.

CARNELIAN, or RED CHALCEDONY, *Ch. carneolus.*

Blood-red, semi-transparent, of a perfectly-conchoidal texture. Found in Arabia and Hindoostan, Egypt, and various parts of Europe, generally in roundish pieces, and also in layers in agate: colour various shades of red: rarely opaque, and sometimes turbid with a few cloudy shades: outer surface rough and uneven, the fragments indeterminately angular and sharp-edged. The word *carneolus* is perhaps expressive of the flesh-colour of this mineral. Carnelian, often called cornelian, is sometimes imported from India in the form of irregularly-shaped nodules, very much resembling Scotch pebbles; and a transverse section of these nodules very often presents a similar arrangement of concentric lines with that of the common agate: of which it is now generally considered a variety. The nodules of carnelian have generally a reddish-brown coloured crust. The most striking colours of the carnelian are that deep flesh-red peculiar to it; and a bluish white, very like the colour produced by the mixture of a little milk with a great deal of water. Arabia and India produce the most beautiful carnelians; but the greatest number come from Germany.

SARD, or WHITE CARNELIAN, *Ch. Sardus.*

Whitish, sometimes variegated with blood-red dots, or streaks. It is found in Italy, the Palatinate, and Sardinia; from which last place some derive the name; others from its resemblance in colour to the flesh of the anchovy (*sardinas*) when salted. Dr. Kidd mentions a gem of this kind which was cut as a cameo; the device was a head of Bacchus; and it was so contrived, that the red part represented the cheeks, the rest being entirely white.

MOCHA STONE, *Ch. dendriticus*.

According to some it is called Mocha stone from the place of its importation; for they say that it is only shipped at Mocha, after having been brought there from a distance; but it occurs in Iceland, the Palatinate, and other parts of Europe. According to others the term is derived from a word signifying *moſs*; this variety of the agate sometimes appearing to contain that vegetable. The ground of the Mocha stone is generally semitransparent, and of a light brownish honey colour; with representations of the form of leaves, moſs, and vegetable fibres of a brown and black colour.

PLASMA, *Ch. maculatus*.

Marked with spots differing in colour and in degree of transparency. Found in Ceylon, the Ferro islands, Italy, and the Palatinate, according to Linnæus; but Dr. Kidd ſays, that its native ſituation is unknown; having been hitherto found only among the ancient ruins of Rome.

SARDONYX, *Ch. fasciatus*.

This term was originally applied to a ſtone, the colour of which was compounded of the onyx and ſard. Carnelians are ſometimes of that yellowiſh red colour which would reſult from an intimate mixture of the two; but the ſardonyx of modern jewellery is a variety of the onyx of the preſent day. The true ſardonyx, however, is found in Ceylon, Ferro and Iceland, Bohemia and Saxony: colour grey, ſomewhat pellucid, with milk-white diaphanous bands, rarely with thoſe that are roſy or green, ſometimes bluifh or blood-red, with white or grey bands.

ONYX, *Ch. onyx*.

Breaking into concentrically-cruſtose fragments differing

fering in colour and degree of transparency. Found in the East Indies, Siberia, Bohemia, Portugal, and Saxony, in thicker or thinner fragments, and sometimes in pebbles. Colours grey and black, white flesh-colour and black, red and white, white and grey, various shades of yellow, alternating in various manners, generally in concentric circles: it loses its colour in the fire, and cracks and breaks if the heat be sudden or violent: it is the hardest of all its genus. Specific gravity from 2.5 to 2.6.

The value of this substance in jewellery depends particularly upon the difference in the colour of the strata: and in engraving heads or whole figures upon the onyx, in *relievo*, as it is technically called, the upper stratum is made use of for the representation of the intended figure; the lower, for the base on which this is to rest. In engraving in *intaglio* this order is reversed, and the figure is cut in the lower stratum. In the former instance the figure is convex, and projects from the inferior stratum; in the latter it is concave, and sinks in from the superior stratum. In some varieties the strata are four or five, or even more, in number; and the colours, of very different shades: these, when cut into a spherical shape, closely resemble the eyes of various animals; the upper stratum being brought to a point answering to the pupil. From the resemblance of specimens of this kind to the eyes of different animals have arisen various terms expressive of the particular resemblance: as *leucophthalmus*, *erythrophthalmus*; and, with a reference to the number of the zones, *diophthalmus* and *triophthalmus*; again, from a resemblance to the eyes of particular animals, *lycophthalmus*, *aigophthalmus*, &c. They are sometimes called by the Italians *occhi di gatti*; but that they are not the true cat's eye, which we have already seen is a species of feldspar.

CHRYSOPRASE, *Ch. chrysoprasus*.

Green, with hardly any internal lustre, semitransparent,

rent, of a flatter texture. Found in Germany, particularly near Breslaw in Silesia, generally in solid masses, sometimes in loose pebbles, or layers of asbest, talc, lithomarg, and iron ochre; internally it is dull; is hard, but does not strike fire with steel. Colour various shades of apple-green. In a heat of 130° of Wedgewood it whitens and becomes opaque, but does not melt before the blowpipe. Specific gravity 3.250. Contains silica 96.16, oxyd of nickel 1, lime 0.83, alumine 0.08, oxyd of iron 0.8. Polished specimens of this substance are particularly beautiful on account of their colour; and sometimes they have a considerable degree of transparency: but it is difficult to obtain them of a large size without flaws or clouded specks. Chrysoprase is said to lose much of its colour when kept in a warm and dry place.

BLOOD-STONE, *Ch. heliotropius*.

Diaphanous, of a conchoidal texture, green, with blood-red dots. Found in Asia, Persia, Siberia, Iceland, Bohemia, and Franconia, in rocks of trap. From the beauty of its polished surface, it is much used for ornamental purposes, as snuff-boxes, knife-handles, &c.

ADAMAS, the DIAMOND.

CONSISTING of silica and carbon: slightly ponderous, extremely hard, lamellar, exhibiting a high peculiar lustre, breaking into indeterminate fragments, parasitical, shining in the dark after being exposed to the rays of the sun, attracting light bodies when rubbed or heated: crackling and losing its transparency in the fire, and at 14 or 15° of Wedgewood begins to burn, and at length entirely evaporates.

There is but one species, *Adamas pretiosissimus*, of which there are eight varieties. The best are found in Borneo, the provinces of Golconda and Vissapour, and at the foot of the Orissa mountains in Bengal;

the

the less brilliant kinds in the district of Serra do frio, by Brasil, in South America, generally in loose sand or inclosed in a loamy earth, very rarely aggregate or attached to other fossils. Of all mineral substances it possesses by far the greatest degree of hardness, transparency, and lustre; fracture straight and perfectly foliated. It is either colourless, or red, greenish, yellowish, brownish, black, or steel blue, with sometimes specks and clouds. It is of all gems the most precious; and, from its entirely consuming like an inflammable substance, may probably be considered as a very pure species of coal: it is therefore now very generally considered as an inflammable body; and with Inflammable Substances it is accordingly classed in the recent system of Professor Kidd.

The Grand Duke of Tuscany was the first person who ascertained that the diamond might be dissipated by the joint action of heat and air: his experiments were conducted at Florence, in the year 1694, by means of a burning glass. The Emperor Francis I. repeated the same experiment on the diamond, making use of the heat of a furnace: these experiments were made at Vienna; and here also the diamonds employed on the occasion were entirely dissipated by the action of the fire. But, before the experiments of either of these princes, Sir Isaac Newton, having observed that the refractive power of transparent substances was, in general, in proportion to their density, but that of substances of equal density those which were inflammable possessed the refractive power in a higher degree than those which were not, concluded, from a comparison of the density and refractive power of the diamond, that it contained an inflammable principle. From the same mode of reasoning he drew the same conclusion respecting the nature of water. These opinions have since been fully confirmed: with respect to the diamond, by the experiments above related; and,

and, apparently, with respect to water, by the experiments of M. Lavoisier.

Some of the natural crystals of the diamond have convex surfaces, or even approach to a spheroidal form: but this is the natural form of the crystal, and not the effect of attrition. Diamonds indeed can but rarely acquire a rounded or pebble form: because, being harder than all other substances, they cannot be rounded except by mutual attrition, and they seldom are accumulated in sufficient abundance for this.

The unpolished diamond may be distinguished from the varieties of sapphire, from the hyacinth, and from quartz, &c. in acquiring the vitreous or positive electricity by friction; whereas those substances acquire the resinous or negative: from the spinell, by its superior hardness.

ORDER VI. ADAMANTINE. EARTH.

ADAMANTINUS, DIAMOND SPAR.

CONSISTING of corunda, or adamantine earth, the greater part alumine, a little flux and iron: very hard, ponderous, lamellar with straight foliations intersecting each other in a three-fold manner, breaking into rhomboidal fragments: perfectly apyrrous, and yielding a little to the file. This Order consists of a single genus, and the Genus of a single species,

IMPERFECT CORUNDUM, OR ADAMANTINE SPAR, *Adamantinus corundum.*

Found in China, Bombay, France, and Spain, in granite: colour grey, with often various shades of green, blue, and brown: lustre transparent, and when polished shines like mother of pearl: is sometimes found massive, but most commonly in six-sided prisms. It is used like diamond-powder, for cutting and polishing hard minerals. Specific gravity 3.981. Contains

tains corunda and alumine 84, filex 6.5, oxyd of iron 7.5. Corundum is an Indian term, the meaning of which we are not acquainted with. The Chinese corundum contains a little more than one tenth of its weight of magnetic iron ore, mechanically disseminated through its substance in particles of various sizes; sometimes as large as a hazel-nut: their form is indeterminate. The Bengal corundum contains no magnetic iron: a few grains are occasionally found adhering to its surface. The Chinese corundum is of a deep brownish green colour; that of Bengal is of a light yellowish colour; of Malabar, a reddish brown; of the Carnatic, a greyish or greenish white. The last-mentioned variety is most commonly met with in cabinets; and generally in fragments that more or less approach to a cubic form. The above varieties of corundum are met with in granitic rocks, of which they form a distinct component part after the manner of felspar: and their general appearance is indeed not unlike that of felspar.

ORDER VII. AGGREGATE OR MIXED EARTHS.

GRANITES, GRANITE.

CONSISTING of parts, mostly in the form of crystals, cohering without any intermediate cement, and mixed without any determinate order; generally of a granular texture, hard and durable, and admitting a fine polish: constituting the principal material and nucleus of primitive lofty mountains.

The word *Granite* appears to have been originally derived from the granular texture of the substance to which it was applied. A well-defined granite, according to the present acceptation of the term, consists of quartz, mica, and felspar; which are all distinct from one another: the addition of hornblende, tourmaline, or garnet, is not understood to alter the genus of the stone;

stone; but only to constitute a specific difference. The proportions of these constituent parts vary exceedingly; but the felspar is upon the whole most abundant, and from this in general is derived the predominating colour of granite, of which there are sixty-two species. According to Saussure, the proportion of felspar in Mont Blanc, and the neighbouring rocks, is nearly three fourths: the same rocks scarcely contain any mica; the place of which is supplied by hornblende or steatite; and he reasons from the height of these mountains, which he supposes to have been elevated by subterraneous force from a great depth beneath the surface, that deeply-situated granite in general contains very little mica; strengthening his conclusion by the fact, that those fragments of granite which are thrown out from volcanoes, and which may be supposed to have come from a great depth, contain very little mica.

Sometimes the constituent parts of granite are very distinctly crystallized, particularly the felspar. This is the case in the granite with which the foot-path of Westminster-bridge is paved; which came, according to Mr. Smeaton, from Llanlivery, near Fowey, in Cornwall. At other times the crystallization is extremely indistinct; so that it is very difficult to ascertain the real nature of the rock, from its close resemblance to some varieties of the stone which in Scotland is called *whin*. Whoever has travelled in those parts of Scotland which abound with granite and whin, and has directed his observation to this fact, must have had frequent opportunities of verifying it: and, partly in consequence of this great similarity, Dr. Hutton supposes that granite, like whin, has once been in a state of igneous fusion; and that, having been forced up from the deeply-seated mineral regions, it has elevated the strata at the same time. Mr. Playfair, from whom the foregoing observation is taken, adds justly, as it appears, that granite has evidently

dently undergone a change from a fluid to a solid state; as is evinced from the crystallized structure in which some of its component parts are usually found: and Mr. Gregory Watt has rendered it highly probable, by the results of his experiments on basalt, &c. an account of which is contained in the Philosophical Transactions for 1804, that this fluid state was the consequence of simple heat. He at least has done away one strong argument against the supposition, by showing that in masses which have been vitrified and cooled slowly, crystallization actually goes on after the mass itself has been consolidated: for, as from the mutual impression of the crystallized parts it appeared that in some instances the least fusible were last crystallized, it seemed impossible that this crystallization could have taken place from a state of igneous fusion.

According both to Mr. Kirwan and Dr. Hutton, granite is almost universally the basis on which other rocks, primitive as well as secondary, rest. It rarely contains metallic minerals; but of these principally tin and some varieties of iron ore. Though extremely hard, it is capable of being worked with tolerable accuracy by means of picks and wedges: and, according to Mr. Smeaton, the harder it is, the more accurately it can be worked.

TRUE GRANITE, *Gr. geminus*.

Consisting of feldspar, quartz, and mica. This most common kind of granite is found in primitive and sometimes in secondary mountains in most parts of the globe, in innumerable varieties of hardness, proportion, distribution, and colour of parts. Sometimes it is found mixed with other minerals, as hornblende, crystals of garnet, steatite, and alumine. It melts in a high degree of heat, leaving however the quartz unaltered: the feldspar is often flesh-colour; the quartz generally white, rarely greenish. It takes

a very high polish, and on this account has for many ages been used in the architecture of columns, palaces, churches, and various ornaments.

SYENITE, OR GREENSTONE, *Gr. syenites.*

Consisting of feldspar, quartz, and hornblende. Found in Egypt, Greece, Norway, Saxony, &c. sometimes in large masses, sometimes in smaller granulations: the component parts vary much, but the hornblende and feldspar generally predominate, and the quartz in very small proportion: the colour of the feldspar and quartz is generally white, and the hornblende black or black-green.

GNEISSUM, GNEISS.

COMPOSED of parts cohering together without any intermediate cement, often in the form of crystals, and sometimes alternating in layers, of a slaty or rarely a fibrous texture, forming plates laid on each other: found in lofty primitive mountains, generally resting upon beds of granite: hard, not melting before the blowpipe nor mouldering in the air.

Gneiss is, like granite, essentially composed of quartz, feldspar, and mica; but its structure is in the mass schistose, the several laminæ being separated from each other by thin strata of scales or plates of mica; and, from the joint consideration of its composition and structure, it is occasionally called *schistose granite*, and *granitic schistus*. The stone of which Mr. Smeaton built the Edystone light-house appears by his description to have been a species of gneiss having a degree of elasticity. Gneiss appears to be the most ancient rock after granite, being generally placed immediately over it: and, according to Mr. Kirwan, where gneiss is contiguous to granite, its quartz and feldspar are more apparent; and the micaceous part less predominant: where more distant from granite, the contrary happens. Of all rocks, gneiss is the most metal-

metalliferous; and almost every metal has been found in this matrix. The mines of Saxony and Bohemia, and the silver-mines of Königsberg in Norway, are in gneiss. Garnets are very often found in gneiss; and sometimes in very great quantity. There are thirty-one species.

COMMON GNEISS, *Gn. fornacum*.

Consisting of the greater part quartz, and mica. Found in most mountainous countries of Europe, in innumerable varieties of proportion, combination, distribution, colour, and hardness, and is chiefly covered with argillaceous slate, sand, and limestone: it is formed of distinct plates laid on each other, and separated by thin layers of mica, and is generally rich in metallic ores: it is used for laying the beds of large melting furnaces.

MICACEOUS SCHISTUS, *Gn. micaceum*.

Quartz and mica are the essentially constituent parts of this rock; the mica generally predominating considerably. The schistose character of this is much more remarkable than that of common gneiss: but the one graduates into the other almost imperceptibly. The laminæ are sometimes remarkably contorted, as if some force had been applied to them when in a soft state. Micaceous schistus passes insensibly into the state in which it is called *roofing-slate*. It occurs in Norway, forming entire mountains, of a silvery colour and splendour: the plates of mica are extremely thin and closely compacted together, so as to form distinct tables; the quartz is generally disposed in small veins, granulations, or larger strata.

ARGILLACEOUS SCHISTUS, *Gn. Bornii*.

Consisting of quartz, mica, and alumine. Found in the metallic mountains of Hungary, Bohemia, Saxony, and Sweden: and is often used as a whetstone to sharpen scythes and large instruments.

HORNBLLENDE SCHISTUS, *Gn. corneum*.

Consisting of quartz and hornblende. Found at Portsoy in Scotland; Saxony, Norway, and Sweden; colour between greenish and raven black, and gives a greenish-grey streak: texture radiate, and breaking into indeterminate fragments: is hardish, and frequently found mixed with small particles of mica or garnets.

PORPHYRIUS, PORPHYRY.

CONSISTING of distinct crystals of another genus imbedded in a compact hardened paste: massive, varying extremely in age, duration, hardness, and colour. There are sixty-six species, in ten divisions, which take their names from the substance which predominates in the composition of the species, as talc, serpentine, amarus, lime, clay, basalt, lava, pitch, hornstone, and jasper. The names of the species we shall select, or their specific characters, will show to what division they belong.

CLAY PORPHYRY, *P. cotiarius*.

Composed of alumine, and crystals of quartz. Found on the banks of the Rhine, in Saxony, and other places: it has sometimes a few particles of feldspar mixed with it, which, mouldering away, leaves it full of hollows.

TRAP PORPHYRY, *P. antiquus*.

Consisting of trap and feldspar. The basaltic trap is green, the crystals of feldspar white, and varied with black crystals of horn.

PITCHSTONE PORPHYRY, *P. piccus*.

Composed of pitch, feldspar, and quartz. This is found near Misena in Saxony, forming entire mountains alternating with mountains of porphyry and clay,

in horizontal strata. Colour black, green, brown, or red.

HORN PORPHYRY, *P. schistofus*.

Consisting of hornstone and feldspar, of a slaty texture. Common in Bohemia, Luface, and Fulda, rarely containing ores of metal. Colour generally grey, rarely black, and often marked with arbore-scent ramifications: in Italy it approaches to a basalt, and melts in the fire to a yellowish glass, but not so easily as basalt. The chert and feldspar are mixed in various proportions, to which is sometimes added hornblende; rarely mica, garnets, or spar; very rarely veins of marble.

HORNSTONE PORPHYRY, *P. nothus*.

Consisting of hornstone and feldspar, of a splintery texture. Found in various proportions of constituent parts and colours, in the mountains of lower Italy, Hungary, Bohemia, Luface, Saxony, Carinthia, the boundaries of the lower Rhine, and Denmark. There are five varieties, some of which exhibit particles of hornblende, mica, and shorl.

TRUE OR JASPER PORPHYRY, *P. genuinus*.

Composed of jasper and feldspar. Found in Egypt, Arabia, Greece, Italy, South of France, Siberia, and most parts of Europe, sometimes detached, sometimes forming rocks, mountains, or their principal parts; opaque, of a texture more commonly approaching to the conchoidal than the slaty, hard and admitting a fine polish, breaking into indeterminate fragments, easily melting in the fire; generally of a common form, rarely in prisms, and then always mixed with other bodies, as hornblende, mica, shorl, or quartz; infinitely varying in the colour, form, distribution, and mixture, of its constituent parts. The feldspar generally white or reddish, immersed in jasper in the form
of

of dots, spots, stripes, or prisms, and sometimes mouldering away and leaving cavities; the jasper red, brown, black, or green, rarely dull grey or of two colours, as black and green, red and orange. It was used by the ancients in the structure of columns, temples, and edifices of the highest orders. The name *Porphyry* was probably derived from the purple red colour of that variety so commonly met with in Egypt, between the Nile and the Red Sea. The *leucostictos* of Pliny is perhaps the same; for so it might be called from the white specks disseminated through its substance: these specks are crystals of feldspar, though not often accurately defined. Incompletely-quarried obelisks are still to be seen in those rocks which are situated between the Nile and the Red Sea. Some of the remains of ancient sculpture are a porphyry having a very dark green base, with crystallized feldspar of a greenish white colour: this is probably the *Saxum Thebanum* and *Ophites* of the ancients. No statues of this are remaining; and only a few columns.

AGATE, *P. achates*.

Composed of jasper, quartz, rock-crystal, amethyst, chalcedony, cornelian and onyx, hornstone and flint, variously combined together. Found in infinite varieties of proportion and distribution of parts, tinge of colours, hardness and lustre, in Britain, Ceylon, and most parts of Europe; sometimes detached, sometimes imbedded in clay, rarely in veins or a stalactitical form; and is used for rings, ornaments, and the decoration of nobler edifices.

AMYGDALITES, ALMOND-STONE.

CONSISTING of various rounded or elliptical stones of different sizes, imbedded together, and forming an irregular mass: occurring principally in mountains of a later date, and generally mouldering when exposed to the air. There are fifty-five species, in
four

four divisions, according as the base is talc, lime, clay, or flint. Belonging to the third division is the

COMMON ALMOND-STONE, *A. vulgaris*.

Composed of trap and spar. Found in Derbyshire and other parts of Britain, in Italy, Saxony, Bohemia, Hungary, &c. in stratified mountains, and is often the matrix of agate and chalcedony. The spar is always white, with sometimes a coating of green alumine: the glandules are larger or less, and more or less thickly dispersed through the mass, which is red, brown, green, grey, or black: there is likewise often an admixture of mica, green alumine, or feldspar.

BRECCIA, PUDDING-STONE.

CONSISTING of fragments of stones, generally of a rounded form, conglutinated by an earthy or metallic cement: found only in mountains of a more recent date. The word *breccia* is from the German *brechen*, to break. There are twenty-three species, in four divisions as before.

COMMON PUDDING-STONE, *Br. filicina*.

Consisting of fragments of hornstone, flint, and quartz, conglutinated by a cement of jasper. Found in Britain, particularly in Herefordshire, and Bohemia; the pebbles are often variegated, and the cement grey or tawny. It receives a fine polish.

GREEN BRECCIA, *Br. Ægyptia*.

Composed of agglutinated fragments of green hornstone. Found in Egypt, and receives hardly any polish: it is often mixed with fragments of granite.

ARENARIUS, SAND-STONE.

CONSISTING of grains of sand cemented together: occurring in stratified mountains, and forming entire strata, rocks, hills, or mountains: generally of

a common form, and breaking into indeterminate fragments.

Sandstone, often also called grit-stone, or simply grit, is to pebble-stone what sand is to gravel or pebbles. It occurs very commonly in the northern part of England in regular strata: in the southern part, chiefly in the form of irregular masses imbedded in sand, &c.

In those parts of Derbyshire where coal is found, there are two different strata of sandstone. One of these consists of a large-grained sand of a very faint flesh-colour, apparently cemented by minute particles of an opaque milk-white substance, somewhat resembling earthy feldspar: the compound would not be unlike some varieties of the white granite of Cornwall, provided the proportion of that opaque white substance were greater. The other sandstone of Derbyshire is cemented by argillaceous particles: it is of a much smaller grain than the preceding. The sandstone of which Windsor Castle is built consists of minute grains of quartz simply aggregated. It is found in the form of very large irregularly pebble-shaped masses, imbedded in sand or clay, in different parts of Oxfordshire and Berkshire. The neighbourhood of Godstone in Suffex affords numerous masses of stone of this kind: and that place is said to have derived its name from the frequent use of this stone in the construction of churches and religious houses. Those very large stones that compose the outer circle of Stonehenge are a sandstone of this nature; which is in some places very hard and compact; in others, remarkably friable. The sandstone of Worcestershire and of the midland counties of England is of a loose texture, and of a red colour. Owing to the looseness of its texture it is easily disintegrated; and hence the sandy soil that is met with in the neighbourhood of Ombersley, Halefowen, and many other parts of Worcestershire, Shropshire, &c. This sandstone is
the

the base of the green glass made at Stourbridge; the iron, contained in it, imparting the green-colour. In many instances it passes into the state of a loosely-aggregated pudding-stone. The sandstone of the northern part of England and of the south of Scotland is hard, and of a broad schistose structure. In the neighbourhood of Newcastle it is employed for making those circular grindstones so common in all parts of this country. The flags with which the foot-way of the streets in London are paved are of this sandstone; of which there is a very productive quarry in the neighbourhood of Edinburgh. That quarry is remarkable for affording a very good illustration of the nature of a stratified rock; the seams, or separations, of the different strata, being very obvious.

Many sandstones contain minute particles of mica, irregularly disseminated through their substance, or deposited in more than usual abundance between the laminae. Many of the mountains of Breconshire and Radnorshire are a brownish-red micaceous sandstone; the colour owing to the presence of an ochry clay. The disintegration of them seems to have produced that red clay so common in those and the neighbouring counties. The rock on which Nottingham Castle stands is a loosely-aggregated sandstone, containing numerous small siliceous pebbles. Similar but larger pebbles are met with, though not so frequently, in the sandstone near Perth.

The sandstone met with at Fontainebleau, which is used for paving the streets of Paris, is remarkable for containing groups of rhomboidal crystals. They are found in cavities of the sandstone, and are supposed to have been formed by the infiltration of particles of calcareous carbonat into the substance of it. It is a very curious circumstance, that, though the form of these crystals is that of one of the varieties of crystallized carbonat of lime, and is certainly owing to the presence of calcareous matter; yet the proportion of

this is not more than one third. There are thirty-five species, in five divisions.

I. *Simpler, with a siliceous cement.*

ELASTIC SANDSTONE, *A. flexilis.*

Elastic, hard, apyrous, in somewhat-scaly particles. Found in Brasil: of a hoary colour, rough, and not effervescing with acids. In larger pieces it may be easily bent backwards and forwards, when it returns into its former position with a small spring and a slight degree of crackling noise. In a white heat it does not lose the least quantity of its weight, nor, as far as respects its smaller particles, of its transparency.

SILICEOUS SANDSTONE, OR GRINDSTONE, *A. Cos.*

Hardish, brittle, not taking a polish, consisting of small equal grains. Found in Britain and various parts of Europe, of a rufous, yellowish, white, or grey, colour; sometimes mixed with particles of mica, or containing vestiges of shells: it is chiefly used for grindstones, scythe-stones, and buildings; and is supposed to produce consumption in those who inhale its fine dusty particles.

FILTERING-STONE, *A. filtrum.*

Hard, filtering water, consisting of large equal grains. Found in the Canaries, on the shores of New Spain, in Saxony and Bohemia, generally grey with pellucid angular grains. Its chief use is to render salt waters sweet, or turbid ones clear.

ANGULAR SANDSTONE, *A. fundamentalis.*

Hardish, consisting of unequal, angular, opaque, large, grains. Found in Great Britain, particularly in Devonshire and Cheshire, in Sweden and other parts; rigid to the touch, difficult to be cut into pieces, falling into sand in a small degree of heat: colour
white,

white, grey, greenish, brown, red, or yellowish. It is rather solid, and when cut horizontally is used for the foundation of buildings.

II. *With a calcareous cement.*

CALCAREOUS SANDSTONE, *A. Livonicus.*

Grey, hardening in the air, consisting of smaller grains cemented by white chalk. Found in Livonia, and becomes yellowish when burnt.

QUARRY SANDSTONE, *A. quadrum.*

Hardish, consisting of small grains conglutinated by a cement of marl. Found in Great Britain, Germany, Sweden, France, &c. grey, yellowish, or reddish, and forming horizontal or oblique clefts: under ground it is moist and easily cut, but hardens when exposed to the air, and at length moulders; is bibulous when quite dry, and scales off in a frosty air. It is principally used in architecture.

III. *With an argillaceous cement.*

FLAT SANDSTONE, *A. fissilis.*

Separable into tables or plates. Found in Britain, Sweden, Spain, Germany, &c. varying much in degrees of hardness, size, and transparency of its grains, thickness of the plates into which it may be separated, and colour, but is generally whitish or reddish. It may be used for tiling, unless it be too porous.

IV. *With a metallic oxyd supplying the place of a cement.*

FERRUGINOUS SANDSTONE, *A. ferruginosus.*

Consisting of grains conglutinated with a large portion of oxyd of iron. Found in Great Britain and Germany, of a brownish or yellowish colour, and is frequently impressed with the casts of shells. It is

sometimes so rich in iron-ore as to be worked with advantage.

V. *More compound.*

MILL-STONE, *A. molaris.*

Hard, consisting of unequal angular grains of quartz and feldspar interspersed with mica. Found generally through Europe: is of a very hard texture, and is used for corn-mills. The grains of quartz are transparent, generally white, and larger; those of the feldspar are less, more opaque, and grey.

TIGER-STONE, *A. variolosus.*

White, in small grains, filtering water, with ferruginous perforations. Found in Nericia and Westrogoth in Sweden: the spots and perforations originate from small pieces of pyrites imbedded, and which moulder into an ochraceous oxyd.

CLASS II. SALTS.

NATRUM, NATRON.

GENERIC characters, Of a caustic taste, effervescing with acids, with oil forming soap, changing blue vegetable juices green, rendering acid solutions of earths and metals turbid.

MINERAL ALKALI, or CARBONAT of SODA,
N. antiquorum.

Inodorous, dry, nearly pure. Found in China, Bengal, Persia, Syria, Egypt, South America, Denmark, Swisserland, and Hungary, generally during the spring and summer, in a state of whitish efflorescent powder, and most usually combined with a greater or less portion of earth, common salt, acid, and various substances; it is totally soluble in water, and after evaporation runs into four-sided prismatic crystals terminating

minating each side in a needle-like point, which on exposure to the air soon moulder into a snowy impalpable powder: with quicklime and oil it forms soap, it easily melts in the fire, and with filix forms glass.

To the west of the Delta of Egypt are several lakes, some of which contain common salt, or muriat of soda, in solution; others, natron, or carbonat of soda. In some of these lakes both these substances are contained, and are deposited alternately on the sides of the lake in consequence of the evaporation of the water that held them in solution; this alternate deposition depending on the different degrees of solubility of these salts: the common salt, being the least soluble, is first crystallized; and when that has been separated to such an extent as to leave a considerable excess of carbonat of soda, or natron, in solution, then, according to the law observed by Berthollet and alluded to by Mr. Watt in his experiments on ferrilite, this latter substance begins to crystallize. Berthollet, who attentively examined the situation of these lakes, and the nature of the surrounding country, found that the soil of the neighbourhood was strongly impregnated, partly with carbonat and partly with muriat of soda. He supposes that the natron, or carbonat of soda, is the result of the decomposition of the common salt by means of carbonat of lime; during which process the lime combines with the muriatic acid of the common salt, forming with it muriat of lime; while the carbonic acid, thus disengaged from the lime, combines with the soda, and thus forms the natron.

The terms *natron* and *nitrum*, which are used indiscriminately in the works of the early natural historians, are most commonly applicable to the substance at present under consideration; but they are sometimes applicable to saltpetre, the *nitre* of the present day; and sometimes to sal ammoniac, as it is usually called, which is a chemical saline combination of ammonia, or hartshorn, and muriatic acid. But carbonat

nat of soda may be distinguished from other mineral saline substances, by its effervescence upon the addition of any strong acid; by its alkaline taste; and by the property which it possesses of changing vegetable blue colours to green.

VOLATILE ALKALI, OR CARBONAT OF AMMONIAC,
Natrum volatile.

Fetid, mixed with earths and other salts. Found in various soils, in chalk, swinestone, argils, and often in the natron of old walls: its odour originates in the ammonia of decayed living bodies.

BORAX, BORAX.

OF a slightly caustic taste; rather ponderous, semitransparent, shining, inodorous, fixed: requiring a large quantity of water to dissolve it, and the solution not rendered turbid by a mixture of soda: frothing in the fire, and at last melting into a transparent glass still soluble in water.

BORAX TINCAL, OR BORAT OF SODA, *B. tincal.*

Combined with a large proportion of soda, mouldering in the air. Found in India and Japan, in the kingdoms of Thibet and Peru, sometimes in the form of solid grains and small roundish lumps, forming in their solution minute semitransparent crystals, sometimes held in solution, and found in vast masses mixed with the mud at the bottom of the lakes after the water has been dried up: it is soluble in twelve times its weight of water at a temperature of 60°, but of boiling water it requires only six: when dissolved and slowly evaporated, it shoots into hard transparent very finely transversely striate crystals, which are six or four sided, terminated both ways by a three-sided pyramid: when heated it swells, and is at first converted into a white opaque frothy mass, but in a stronger heat becomes a transparent glass: when two pieces are struck together

together in the dark, a flash of light is emitted. Specific gravity 1.74. Contains acid 39, soda 17, water 44.

The name *borax* occurs in Geber, who wrote in the ninth century; and is derived from the word name it in use among the Arabians. *Tinkal* is the *Baurach*, bears in India, while it is in an impure state. The origin of borax is not known: it is probable that it is separated by the process of evaporation from the water of certain lakes, or extracted by lixiviation from the soil, in different parts of Persia, and the north of India. It may be distinguished from alum by its sweeter and less astringent taste; and by not approaching to the cubic or octohedral form so commonly observable in the crystals of the latter substance. It is, besides, the only soluble salt that is converted into a glass by the blowpipe: which property therefore distinguishes it from saline substances in general.

MURIA, MURIAT.

OF a salt taste: easily soluble in water, and the solution not made turbid by soda: not effervescing with diluted acids, but effervescing and emitting grey ill-favoured suffocating vapours in strong hot sulphuric acids: changing nitrous acid into the nitro-muriatic acid.

SEA SALT, *Muria aquatica*.

Fixed, decrepitating when heated, of a cubic form, dissolved in water. Of this there are three varieties, as it occurs, 1. in the ocean; 2. in salt lakes; 3. in salt springs. When evaporated it generally contains from 20 to 30 per cent. of muriat of soda.

COMMON OR ROCK SALT, OR MURIAT OF SODA, *M. montana*.

Fixed, decrepitating in the fire, dry, pure; producing sulphat of soda when saturated with sulphuric acid.

Found

Found in Britain, Poland, Hungary, Spain, and various other countries, sometimes forming vast masses and mountains: it is found colourless, and of various shades of grey, yellow, red, blue, or brown: it is frequently contaminated by a mixture of muriat of lime, muriat of magnesia, or other earths, and may be purified by dropping into it first a solution of carbonat of barytes, then of carbonat of soda, as long as any precipitate continues to fall; then separate the precipitate by filtration, and evaporate slowly till the salt crystallizes: it is soluble in something less than three times its weight of water. Specific gravity 2.12. Contains acid 52, soda 42, water of crystallization 6.

Rock salt is generally accompanied by gypsum and indurated ochry clay: and is always situated among secondary strata. In some parts of the world it has been employed instead of stone, in building: this use of it is mentioned by Strabo and Pliny. The rock-salt of Cheshire is of a brownish red colour, in consequence of the presence of an ochry clay: this clay is immediately separated by solution and crystallization; subsiding to the bottom of the water in which the salt has been dissolved, and leaving the supernatant liquor clear; from which the salt may be recovered by evaporation of the water that held it in solution, in a perfectly colourless state. Transparent colourless patches of salt occur here and there in the natural stratum; but upon the whole this is of the colour above described, and the appearance of the mine is much the same as of a quarry of common stone of the same colour. Mr. Playfair describes a peculiarity in the rock-salt of Cheshire. He says that the mass is compact, but arranged in nodules of five or six feet diameter: these nodules are not perfectly spherical, but each is compressed by those that surround it, so as to have the shape of an irregular polyhedron.

Pallas speaks of rock-salt in the neighbourhood of the river Jaik, which is sometimes so hard as to snap the

the pick-axes made use of in quarrying it: he adds that this salt is generally white; often as transparent and colourless as crystal: and that it readily breaks into cubic fragments. He observes that the southern parts of Russia, Siberia, and Grand Tartary, are as rich in common salt as any tract of land in the known world. Bruce mentions that in some parts of Abyssinia cubic masses of rock-salt pass as current coin.

The brine-springs met with near Droitwich in Worcestershire, from which a great quantity of salt is separated by the process of evaporation, probably communicate with strata of rock-salt: and perhaps these strata may hereafter be discovered; for within the last two or three years a vein of gypsum has been met with in that part of Worcestershire, which alone might lead to the expectation of finding rock-salt.

MURIAT OF ALUMINE, *M. impura*.

Fixed, decrepitating in the fire, dry, producing sulphat of soda when saturated with sulphuric acid; mixed with various earths. Found in the Nevil Holt waters, and in the salt-pits of Saltsburg; and is a coarser variety of the last from its being much mixed with gypsum, common mould, clay, and other earths: its taste is astringent.

MURIAT OF POTASH, *M. febrifuga*.

Fixed, decrepitating in the fire, forming muriat of potash with sulphuric acid. Found in the environs of Madrid, and in some mineral waters in Normandy: it has a disagreeable bitterish taste, and when dissolved and crystallized forms cubes which are often irregular: it was formerly known in the shops by the name of febrifuge or digestive salt. Specific gravity 1.836; contains acid 31, potash 61, water 8.

MURIAT of AMMONIAC, or SAL AMMONIAC,
M. ammoniaca.

Of an acrid pungent urinous taste, when heated subliming into a white smoke, rubbed with quicklime exhaling an alkaline odour, its crystals deliquescing in the air. Found in coal-pits in various parts of Britain, but principally in the interior parts of Asia and Africa, and in the neighbourhood of volcanos; rarely pure, white, and transparent, generally of a yellowish-grey, apple-green, or brownish-black, colour: it dissolves in about three times its weight of water, and when slowly evaporated forms flexible spicules connected together like the web of a feather. Specific gravity 1.42; contains acid 42.75, ammonia 25.00, water 32.25.

MURIAT of BARYTES, *M. barytes.*

Fixed, decrepitating in the fire, of an acrid astringent taste, precipitating sulphat of barytes when dropt into a weak watery solution of sulphuric acid. Found in some mineral waters of Sweden, and when evaporated forms four-sided prisms whose bases are squares, or tables. It is sometimes used in scrofulous affections in doses of from five to twenty drops; but much precaution is necessary in its exhibition as, like all other barytic salts, it is poisonous.

MURIAT of STRONTIAN, *M. strontiana.*

Of a sharp penetrating taste; when heated undergoing a watery fusion, and afterwards becoming a white powder; precipitated from its watery solution by muriatic acid. Perhaps never found naturally combined, but is prepared by dissolving carbonat of strontian in muriatic acid: its crystals are long slender six-sided prisms, which are soluble in two parts of water, and also in alcohol, to whose flame they give a purple tinge.

MURIAT

MURIAT of LIME, *M. calcarea.*

Of a bitter taste, swelling and melting and losing its water of crystallization in heat, and after having been exposed to a violent heat shining in the dark. Found in mineral waters, but generally combined with common sea-salt, to which it gives a bitterish taste, and which it causes to attract moisture and melt speedily in the air: its crystals are six-sided striate prisms terminated by very sharp pyramids: its earth is precipitated by sulphuric acid.

MURIAT of MAGNESIA, *M. magnesiata.*

Of a very bitter taste, soluble in its own weight of water, its saturated solution quickly forming a jelly on which if hot water be poured spongy masses are formed. Found in salt and other mineral springs, and abounds in the waters of the sea: its solution is precipitated by caustic alkalies, and not visibly by the sulphuric: it very speedily deliquesces in the air, and when dried in a high temperature is very caustic.

NITRUM, NITRE.

OF a sharp, bitterish, cooling, taste: easily soluble in water, and the solution not made turbid by a mixture of soda: not effervescing with diluted acids, but when saturated with concentrated sulphuric acid emitting sharp suffocating red vapours: detonates violently when made red hot, and charcoal is thrown upon it.

NITRE, SALTPETRE, or NITRAT of POTASH,
N. nativum.

Fixed, pure, not deliquescing in the air, when dissolved and slowly evaporated crystallizing into six-sided prisms terminated at each end by an unequal six-sided pyramid. Found in Virginia, Spain, Sicily, India, Persia, and China: white, of a cooling taste and

resisting putrefaction: is very brittle, and soluble in seven times its weight of water: when exposed to a strong heat it melts, and congeals by cooling into an opaque mass: detonates very violently with combustible bodies, particularly with phosphorus. Its principal use is in the composition of gun-powder, which is made by mixing together seventy-six parts of nitre, fifteen of charcoal, and nine of sulphur. It is called *sal petra*, or saltpetre, from its being often found attached to the stone walls of buildings.

MIRABLE, WONDERFUL SALT.

OF a bitter taste; not easily soluble in cold water, and the solution not made turbid by a mixture of soda: not effervescing with any acid: exposed to a white heat with powdered charcoal producing an alkaline sulphur.

GLAUBER'S SALT, OR SULPHAT OF SODA, *M. genuinum.*

Of a cooling taste, easily melting in the fire, when dissolved and slowly evaporated crystallizing into very transparent unequally six-sided prisms which moulder in the air. Found in many mineral waters of Britain and other parts of Europe, sometimes dry, rarely in a crystallized state, sometimes in a state of white efflorescence on moist walls, in vast quantities under the surface of the earth in the neighbourhood of Astracan, and in summer at the bottom of lakes: it is seldom found pure, but usually mixed with soda, common salt, Epsom salt, or selenite. The sides of the crystals are commonly grooved, and when exposed to a warm atmosphere they soon lose their transparency and water of crystallization, and fall into a white opaque powder. When exposed to heat, it first melts, and after the evaporation of its water becomes a white powder, and in a red heat melts. Its use as a cooling purgative is sufficiently known.

SULPHAT

SULPHAT of POTASH, *M. potassinum*.

Of a bitterish taste, decrepitating when placed on hot coals and melting in a red heat, soluble in sixteen times its weight of cold water, its crystals not mouldering in the air. Found in various parts of Spain, of a greyish-white colour, and sometimes luminous in the dark. When its diluted solution is evaporated, it affords six-sided pyramids, or short hexangular prisms terminated by one or more hexangular pyramids. The super sulphat of potash, from its excess of acid, turns blue vegetable juices red, and is soluble in twice its weight of water. It was formerly used as a purgative, under the name of *sal polychrest* and *vitriolated tartar*. Specific gravity 2.298. Contains acid 40, potash 52, water of crystallization 8.

SULPHAT of AMMONIAC, *M. sulphureum*.

Evaporating in fumes when heated, deliquescing in the air, when rubbed together with quicklime emitting an alkaline odour, and when sprinkled with nitric acid an odour like burnt sulphur. Found in the neighbourhood of volcanos, in some lakes in Tuscany, at the bottom of a burning well in Dauphigny, and on the surface of the earth near Turin. It is generally found mixed with sulphur, alumine, alum, or vitriol; and hence its colour is seldom white, but of a grey, yellowish grey, or lemon-colour: it is also found in a stalactitical form, or investing lavas, or in an earthy state with little or no lustre: its crystals are generally small six-sided prisms whose planes are unequal, terminated by six-sided pyramids: it is soluble in twice its weight of cold water, and slowly attracts moisture when exposed to the air: when heated it first decrepitates, then melts, and in close vessels sublimes. Contains acid 54.66, ammonia 14.24, water 31.10.

AMARUM,

AMARUM, BITTER SALT.

OF a bitter taste: easily soluble in water, and the solution becoming milky by a mixture of soda: easily melting in heat, but neither detonating or decrepitating. There are six species, of which we shall notice only the

SULPHAT OF MAGNESIA, OR EPSOM SALT,
Amarum genuinum.

Foaming in the fire, when dissolved and evaporated crystallizing into four-sided prisms terminating each side in a four-sided pyramid, and which wither when exposed to the air. Found in many mineral waters of Britain and other parts; at Jena on gypsum, in Switzerland in a powdery state, sometimes in a state of incrustation covering the surface of the earth; in sea-water it abounds, and frequently renders the salt prepared from it bitter. Before the blowpipe it melts with difficulty into an opaque glassy globule. Its use is well known as a purgative; and the magnesia of the shops is prepared from it, by dissolving it in water, and precipitating the magnesia contained in it by means of alkalies.

ALUMEN, ALUM.

OF a sweetish and very astringent taste: its watery solution made turbid by soda, but not by prussiat of lime: tumefying and losing its transparency when exposed to heat, and becoming a spongy mass after losing its water of crystallization.

NATIVE ALUM, *A. nativum.*

Pure, dry, not emitting vapours when sulphuric acid is poured on it. There are five varieties. Found in Egypt, the islands of the Archipelago, Malta, Sicily, in the craters of volcanos, the alps of Switzerland, and the lakes of Tuscany, and in various parts of

of Europe, in aluminous shist: it is dissolved in thirty-four times its weight of cold water, and easily forms crystals which effloresce a little in the air: when exposed to a strong heat it sublimes, swells, foams, loses its transparency, and at last loses forty-four per cent. of its weight: its solution always turns vegetable blues red. Contains sulphat of alumine 49, sulphat of potash 7, water 44.

CAPILLARY ALUM, OR HAIR SALT, *A. halotrichum*.

Dry, fibrous, of a silky lustre, not deliquescent in the atmosphere, nor emitting vapours when sulphuric acid is poured on it. Found in the quicksilver-mines of Idria, the lakes of Tuscany, in Italy, Sicily, Hungary, and the coal-mines near Whitehaven; the crystals are tender capillary silvery-white filaments, generally parallel and incurved, rarely disposed in a stellate manner, which frequently adhere together and form compact pieces; these, after exposure to the air, lose their transparency and become more or less of a yellowish or greenish hue. Pliny seems to describe this species in the following passage: "Concreti aluminis unum genus *schiston* appellant Græci, in *capillamenta* quædam canescentia dehiscens. Unde quidam *trichitin* potius appellavere." Nat. Hist. vol. vi. This may by the eye be easily mistaken for a variety of sulphat of iron, which closely resembles it in colour as well as form: but the sulphat of iron has a much more astringent taste, and produces a black colour when added to the infusion of oak-bark, or gall-nut. It may also by the eye be mistaken for fibrous gypsum, or for amianthus; but may at once be distinguished from these by its taste and solubility.

STONE OR MOUNTAIN BUTTER, *A. butyraceum*.

Of a yellow colour in its native soil, soft and fat to the touch, hardening in the air and becoming white, of a waxy lustre, lamellar. Found in Siberia and
Upper

Upper Luface, oozing from the surface of aluminous shist: it is a little semitransparent, soft and friable, but becomes brittle by exposure to the air, and contains decomposed sulphat of iron as well as alum.

ROCHE OR ROCK OR ROMAN ALUM, *A. Romanum*.

Adhering to the tongue, soiling the fingers, not emitting vapours when sulphuric acid is poured on it, combined with indurated purer alumine. According to Wallerius, who refers to Leibnitz, this term is derived from *Rocca* in Syria; from whence the method of artificially preparing alum was introduced into Europe about 350 years since. According to Kircher, the district of Tolfa, situated about ten miles from the Tyrrhene sea, is full of *rocks*, which, when roasted for twelve or fourteen hours, afford alum by evaporation: and hence the term *rock alum*. The species is found in Britain near Whitby, in Switzerland, and Tuscany, as well as at La Tolfa near Rome, forming strata or vast masses, with frequently small lumps of pyrites or sulphat of iron interspersed, and having sometimes veins of white quartz running through it: does not effervesce with acids, is of a white, grey, perlaceous, or rosy, colour; and produces alum upon combustion, or after long exposure to the air. Kircher, in describing the artificial preparations of alum, says, that the fragments of the aluminous rock are first roasted; and then heaped up in a conical shape, and exposed to the sun: afterwards, for the space of a month, they are affused four times a-day with cold water, which disintegrates and reduces them to a kind of argillaceous paste. This is thrown into cauldrons and boiled; and the liquor is afterwards withdrawn, and made to crystallize by the process known to the manufacturer.

As iron is always present in greater or less proportion in aluminous shale, and as the sulphuric acid combines with that metal very readily, all the natural forms
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of alum contain some portion of iron: the combination of the acid with the iron produces the metallic salt commonly called green vitriol; and from the presence of this salt arises the occasional light-green colour of natural alum. It happens that the species properly called *Roman alum* is derived from an aluminous earth which scarcely contains any iron; and owes its purity to the absence of that metal. By degrees the term has been extended to any pure form of alum. Wallerius says that Roman alum is obtained by lixiviating a white aluminous earth met with at Tolfa, in the territory of Civita Vecchia, in Italy.

ALUMINOUS EARTH, *A. commune.*

Not emitting vapours when sulphuric acid is poured upon it, mixed with bituminous shist. There are three varieties: 1. Very soft to the touch, meagre, breaking into trapezoid fragments. 2. Hardish, shining internally, undulately flaty, a little greasy to the touch, breaking into indeterminate fragments. 3. Slightly effervescing with acids. They all occur in the neighbourhood of coal-mines in many parts of England, Scotland, and Wales; in Siberia, Norway, Sweden, many parts of Germany, &c. forming vast mountains, and strata over coals and iron ore; it is also found in small flatted spherical masses, containing small particles of sulphuret of iron in the form of pyrites. Colour black, gives a dark grey streak, adheres a little to the tongue: texture flaty, sometimes straight, sometimes curved, and has a sweetish and somewhat astringent taste, and is apt to wither in the air into a dull grey powder. It is used in alum-works.

VITRIOLUM, VITRIOL.

OF a very caustic taste: its watery solution made turbid both by soda and prussiat of lime: very soft, mouldering in the air: dissolving like water when exposed to heat, and in a very strong degree leaving a genuine metallic oxyd.

SULPHAT OF COBALT, *Vitriolum magnesi.*

Of a rosy-red colour, its watery solution depositing an ochraceous sediment when dissolved soda is poured into it, and a greenish one when a solution of prussiat of lime is poured into it. Found in the mines of Neusohl in Hungary: it is soluble in sixteen times its weight of cold water, and melts with borax into a blue glass: when crystallized it exhibits an elongated eight-sided prism.

SULPHAT OF NICKEL, *Vitriolum niccoli.*

Green, its watery solution depositing a whitish-green sediment from a mixture of soda. Found in some mines of Sweden, and usually contains some iron: colour a deep green: it crystallizes in double four-sided pyramids with their tips truncated, and sometimes in large four-sided equal prisms.

SULPHAT OF ZINK, OR WHITE VITRIOL, *V. zinci.*

White, its watery solution depositing a white sediment from a mixture of soda or prussiat of lime, and when evaporated crystallizing into four-sided prisms terminated at both ends by a pyramid. Found in the copper mines of Cornwall and Anglesea, and in the zinc-mines of Sweden, Bohemia, Germany, and Hungary; rarely in its perfect native state, but generally in a stalactitical or capillary state, or in a loose powdery efflorescence: it is sometimes blended with a little iron, and then tincture of galls turns its solution blackish: the crystals are soluble in something more than twice their weight in water, and effloresce slowly on exposure to the air. It is colourless, when pure; when it contains any considerable proportion of iron it is of a light greenish yellow. Specific gravity, when pure, is 1.91. This substance is obtained by artificial processes from the ore of zink called *blende*, or sulphuret of zink, much in the same manner as sulphat

phat of iron or of copper from iron or copper pyrites: but it is very rarely formed by the spontaneous alteration of blende. As in almost every instance blende contains some portion of iron, the white vitriol of commerce, unless subsequently purified, necessarily contains a correspondent proportion of green vitriol; and hence its occasional greenish-yellow colour.

SULPHAT OF COPPER, OR BLUE VITRIOL, *V. cupri*,

Of a deep blue colour, and very astringent acrid taste; its watery solution, when copiously mixed with a solution of volatile alkali, becoming a fine sky-blue. Found in the copper-mines of Wicklow in Ireland, in France, Germany, Saxony, Hungary, Sweden, &c. sometimes in a state of solution, sometimes crystallized or stalactitical: it has a strong styptic nauseous taste, and is commonly used as a caustic: its crystals are four-sided prisms with rhomboidal faces, which are soluble in four times their weight of cold water, and by exposure to the air they slightly effloresce, lose their lustre, and are covered with a yellowish-grey powder; they likewise communicate a green colour to flame. A valuable article of commerce is produced by placing thin plates of iron in the waters where it is held in solution; for the acid, having a greater affinity with iron than copper, gradually decomposes it, and leaves the copper in its place. Contains acid 33, oxyd of copper 32, water 35. Sulphat of copper may easily be distinguished from most other minerals by its blue colour: some other natural forms of copper are also blue, but they are not soluble in water.

SULPHAT OF IRON, OR GREEN VITRIOL, *V. ferreæ*

Green, its watery solution depositing an ochraceous sediment when mixed with a solution of soda, and a blue one with prussiat of lime, made blackish by tincture of galls. Found in Britain and various parts of

the continent, in grottos, caverns, and galleries of mines, in the form of pale green crystals, or in a grey or yellowish or reddish-grey efflorescence, or stalactitical or capillary, and most commonly mixed with copper, zink, or alum; it is also found in solution: when pure it crystallizes into rhomboidal green transparent prisms which are insoluble in alcohol: when heated it melts, gradually loses its water of crystallization, and with a strong heat there remains a red powder, formerly known by the name of *colcothar of vitriol*. Contains acid 39, oxyd 23, water 38.

The natural history of sulphat of iron is necessarily contained, in a great measure, in that of alum. The alum is formed in consequence of the acidification of the sulphur of the pyrites contained in aluminous schist; the acid uniting with the alumine of the shale in the moment of its formation. If you suppose a similar process to take place in insulated masses of sulphuret of iron, where no clay is present, the acid would unite with the metallic substance simply; and the salt in question would be formed. This process often does take place naturally; particularly in pyrites of a radiated structure and globular form. Sometimes it is accelerated or even produced by artificial means, as by roasting the pyrites; and subsequently submitting it to the treatment described above, under the head of sulphat of alumine. In the spontaneous formation of sulphat of iron, the pyrites first loses its splendour: then swells and separates into numerous fissures. After this, its surface is partially covered with a white efflorescing powder, which is the *flos aris* of Pliny. If this be separated by lixiviation, and the lixivium be evaporated, crystals of green vitriol will be obtained.

Green vitriol by exposure becomes yellow, and at last brown: in this state perhaps it answers to the *misf* and *sory* of Pliny. The *melanteria*, or ink-stone, of Pliny seems to be a variety of sulphat of iron that
has

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has been formed in a matrix containing vegetable astringent matter, which uniting with the metallic salt has produced a natural ink. These three varieties are now considered as forming a distinct species, under the name of *Vitriolum atramentarium*.

CLASS III. INFLAMMABLES.

THOSE substances which are called inflammables are not all capable of producing flame: some simply become red-hot when exposed to the necessary degree of heat; and insensibly consume without the phenomena that usually attend the process of combustion. If exposed to a red heat in a vessel from which atmospheric air is excluded, they are in many instances decomposed; and at the same time their elementary constituent principles form either new or differently-modified compounds: these are for the most part volatile, and pass away in the form of water, and of oil or bitumen, and different æriform fluids. That which remains in the vessel consists of earthy and metallic matter, and charcoal. If this residuum be exposed to a red heat in the open air, the charcoal combines with the oxygen or pure part of the atmosphere, and forms carbonic acid gas, or fixed air; which is dissipated, leaving only the earthy and metallic matter. The products of the analysis of inflammable minerals are for the most part—Inflammable air, or hydrogen gas; heavy inflammable air, or carbonated hydrogen gas; fixed air, or carbonic acid gas; water; oil, or bitumen; and charcoal. These substances appear to be ultimately derived from the following three *elementary principles*: 1. Carbon, or the base of charcoal. 2. Oxygen, or that part of atmospheric air which supports combustion; called *oxygen*, because it appears to be the acidifying principle. 3. Hydrogen, or the inflammable principle; called *hydrogen*, because when united with oxygen it constitutes water.

TURFA,

TURFA, TURF.

GENERALLY of a dull colour, and more or less fibrous texture: when burnt, emitting fumes which are exceedingly offensive to the smell and the eyes: consisting of the fibrous roots and other parts of vegetables more or less intermixed, and combined with bitumen.

COMMON TURF, *T. cæspitosa*.

Whitish, light, easily and speedily burning into ashes with flame and a small degree of fumes. There are two varieties: 1. Consisting principally of heath; 2. consisting chiefly of mosses and grasses. Found commonly on moors and heaths, covering the surface of the ground, or covered with a light stratum of the soil only, and is generally in deeper layers than others of its kind: it is composed of the radicles of heath and mosses which have undergone very little alteration, and is pale, hoary, or when contaminated with iron ochraceous: it is so light, that a piece 14 inches long, 6 broad, and 4 thick, will weigh only from 13 to 15 ounces: its vapour is not so disagreeable to the nose and eyes as many others, but it consumes very quick, gives but little heat, and leaves a large quantity of ashes.

DARRY, *Turfa maritima*.

Burning slowly, and emitting most offensive fumes to the nose and eyes. Found in low maritime situations, and in the neighbourhood of salt springs; rather ponderous, of a darkish colour, and takes a longer time in consuming than *T. cæspitosa*, and gives out much more heat.

PEAT, *Turfa palustris*.

Of a dark colour, consolidating in the air, burning quicker and with less offensive fumes. Found every
where

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where in bogs and morasses, and is generally the middle and lower beds under turf, and frequently at the bottom of bogs where the water has laid stagnant: the vegetable substances are quite in a decayed state, and therefore less visible: a brick of 14 inches long, 6 broad, and 4 thick, will weigh from a pound and a quarter to a pound and three quarters: it is, in many places, a principal article of fuel, and its ashes are of considerable value as a manure.

HARD TURF, *T. picca*.

Of a dark colour, consolidating in the air, a little greasy to the touch, impregnated with a large proportion of bitumen, and burning with much heat and fumes. Found on plains at the tops of higher mountains, frequently on those composed of granite, and at the bottom of stagnant waters: after being some time kept, it will burn like coal. It is the most ponderous of its kind, a brick 14 inches long, 6 broad, and 4 thick, weighing about two pounds.

BITUMEN, BITUMEN, including NAPHTHA, TAR, COAL, &c.

GENERIC characters, Easily combustible with flame, and emitting when ignited a strong odour; greasy to the touch.

Some of the products resulting from the distillation of common coal, says Dr. Kidd, very closely resemble the bituminous substances called naphtha, petroleum, and asphaltum. If therefore we suppose a distillation of coal to be going on in the interior of the earth, the production of the different natural forms of bitumen may thus be accounted for: as also the existence of that variety of coal, to which culm and Kilkenny coal belong; which, by the distillation here supposed, may have been deprived of their bitumen. No stress is intended to be laid on this hypothesis further than as it serves for the convenience of arrangement:

range: for, thus having traced the formation of bitumen through its various stages, and shown, in some instances at least, its necessary connexion with vegetable matter, we seem enabled to account for its presence in a separate and insulated state.

FLUID BITUMEN, OR NAPHTHA, *B. naphtha*.

Specific characters, it is fluid, nearly colourless, volatile, and highly inflammable. Naphtha is met with abundantly in Persia and Media, issuing from rocks and clays. It has also been found, according to Mr. Kirwan, at Mont Festin, near Modena, in Italy. The specific gravity of naphtha is less than that of the most highly rectified spirit of wine. By exposure it loses its transparency and odour; acquires a yellowish, or even brown, colour; becomes thicker, and specifically heavier; and approaches in its characters to the next species, Petroleum. In various parts of Persia naphtha is used instead of oil for lamps, &c.

PETROLEUM, OR ROCK OIL, *B. petroleum*.

Liquid, but of a thicker consistence than the last, and not so transparent; coloured. This is found on the surface of certain springs in Persia, Media, and Siberia; or in coal-mines, or oozing out of rocks and mineral beds, in various parts of Great Britain, and of Europe in general. It is of a thicker consistence than naphtha, and a rather less pleasant smell, is lighter than water, but heavier than alcohol: colour yellow, or with a shade of red, or green, or brownish, or blackish: when burnt it yields a soot, and leaves a small quantity of coaly residuum. By exposure it becomes of the consistence of treacle.

MINERAL TAR, *B. maltha*.

Inspissated, black, sticking to the fingers. Found in Colebrook-dale and other coal-counties in Britain, sometimes

sometimes floating on lakes in Palestine, Babylon, Arabia, Persia, China, Barbadoes, and various parts of Europe, and frequently issuing from rocks; is of the consistence of treacle, of a blackish-brown colour, opaque, and has a very strong smell when burnt: it seems to have its origin from the former species, which, by long exposure to the air, has lost its volatile particles, and obtained a thicker consistence.

MINERAL PITCH, *B. mumia*.

Black, inodorous, softening in a low heat. Found in Persia, in the cliffs of rocks at Chorassou, on the river Caucasus, and is said to have been discovered in Lancashire. Colour, blackish-brown, soft and tough like cobbler's wax when the weather is warm, but brittle like pitch in cold weather: it does not stain the fingers, and on a hot iron flames with a rather strong odour, and leaves a quantity of ashes. The Persians value it highly, and after mixing it with about a third part of wax apply it to fresh wounds.

ASPHALTUM, *B. asphaltum*.

Opaque, shining, black or brownish-black, easily melting in heat, effervescing with concentrated nitric acid. Found abundantly in various parts of Europe, Asia, and America; especially in the island of Trinidad, in a plain called Turlane, where it covers the surface of the earth for a considerable distance: its surface is hard, black, shining, and resinous: it easily melts before the flame of a candle, and may be used for the same purposes as sealing-wax; when pure, it burns without leaving any ashes: when hardened is very brittle, and was used by the ancient Egyptians for making mummies: when dissolved in oil it is used as a varnish for leather and other purposes.

The word *asphaltum* is derived from the name of the lake in Judæa, where this substance occurs in great abundance. It first rises in a liquid form to the sur-

face of the water, and there hardens. It differs from the foregoing species principally in consistence. Klaproth analysed a variety of asphaltum, from Avlona in Albania, the specific gravity of which was 1.2. He says that it burns with a strong and lively flame; and is considered as the principal ingredient in the *Greek fire* so much employed in former times. Asphaltum may be distinguished from coal by the smell it emits when rubbed. It is, besides, electric; which coal is not. It is distinguished from jet by its brittleness, and by its peculiar odour when rubbed.

RETINASPHALTUM.—This substance is a natural combination of resin and asphaltum; and hence Mr. Hatchett, who first analysed it, was induced to distinguish it from other bituminous substances by this name. It is met with in moderately-sized masses, among the earthy matter in which the strata of Bovey coal are situated; but adhering to the coal. Its colour is a light ochry brown, and it might by the eye be easily mistaken for a variety of umber: but it possesses a much higher degree of inflammability. When placed on a heated iron, it melts and burns with a bright flame; yielding at first a fragrant odour, which towards the end of the combustion becomes slightly tainted with that of asphaltum.

MINERAL TALLOW, *B. sebum*.

White, rather brittle, floating on water, burning easily with a blue flame. Found in the maritime parts of Finland in the neighbourhood of Narko, and at the lake Loja: it is soluble in cold olive-oil, and in alcohol if mixed with a little alkali: is of the consistence of tallow, lighter than ambergris, and burns quickly, leaving a considerable residuum of ashes.

ELASTIC BITUMEN, or MINERAL CAHOUTCHOUC, *B. elasticum*.

Brown, solid, elastic like Indian rubber. Found in

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in the lead-mine of Odin, near Castletown, in Derbyshire, with calcareous spar. Colour yellowish or reddish-brown, sometimes paler and resembling in colour and texture fine cork: is very elastic, and soft enough to be compressed with the fingers when fresh, but hardens and gets rather brittle by long exposure to the atmosphere: is insoluble in ether, alcohol, and oil of turpentine, but is readily dissolved in oil of olives: burns with a bright flame, and when distilled yields bituminous oil, insoluble in water, leaving a carbonaceous residuum: specific gravity nearly that of water, some varieties more, some less.

HARD BITUMEN, or JET, *B. gagas.*

Compact, deep black, opaque, of a conchoidal texture, shining internally, burning with a greenish flame. Found in various parts of Great Britain, France, Spain, Germany, &c. particularly on the coast of Lowestoft in Suffolk, with impressions of cornu ammonis, sometimes in layers, but generally in kidney-form masses of various sizes. Colour glossy black, glassy internally: texture striated, and conchoidal: when cold has no odour, but when heated emits an odour resembling that of asphaltus: readily inflames, and loses during combustion 14 grains in 20, leaving an earthy residuum: in thin pieces will float for a short time on the water: specific gravity 1.259. It is formed into buttons, beads, and other trinkets: when heated or rubbed hard, will attract light bodies.

CANNEL COAL, or BOVEY COAL, *B. amphetiles.*

Black, opaque, brittle, does not stain the fingers, burns with a bright white flame like a candle. Found in Lancashire, Ireland, and many parts of Europe, of a compact flaty texture, and conchoidal fracture: it kindles easily, and leaves a stony or sooty residuum of a grey colour: it is susceptible of a fine polish, and

like jet may be made into trinkets: specific gravity 1.232, to 1.426.

The following interesting account of the Bovey coal is from Kidd's *Outlines of Mineralogy*, lately published.—“ The substance so called, consists of the branches, trunks, and roots, of trees, that have, to a greater or less extent in different parts, undergone that alteration by which the vegetable principles are charred, and converted into bitumen. Bovey coal is analogous to the *furturbrand* of Iceland; the *piligno* of the Italians; and the several varieties of bituminous wood, sometimes called *legnitè*, met with in different parts of Europe. The general appearance of Bovey coal, and the alluvial character of the spot where it is found, sufficiently manifest its origin; and show that the alteration it has undergone depended on a process analogous to that which takes place in the formation of turf and peat. Some specimens have been lately sent to the museum at Oxford, which have every appearance of the recent vegetable: they appear to have belonged to that part of the trunk which is contiguous to the root; and are of the character of a species of fir. I understand from a gentleman who is thoroughly acquainted with all that part of Devonshire, that the strata of Bovey coal originate from a part of the heath where numerous stumps and roots of trees are remaining: that from this point the strata gently dip, or incline downwards beneath the surface; so that, in proportion as you advance from the roots just mentioned, the accumulation of alluvial matter above the coal becomes thicker. The Bovey coal appears therefore to be the broken trunks and branches of the roots and stumps just mentioned. From the completely vegetable appearance of the specimens above mentioned, the Bovey coal may be traced by insensible gradations into a state in which every feature of the vegetable is lost, and the substance in colour and lustre and fracture

ture completely resembles pitch. In one part of the heath I met with a few small pieces that exactly resembled common charcoal, but were more easily divisible and almost crumbled between the fingers. I did not submit these to a chemical examination; but I found that, when they were employed for the purpose of completing the galvanic circle, no spark was produced; whereas in the case of common charcoal a spark is produced. In some instances the Bovey coal is obtained in the form of straight flat pieces, three or four feet in length, resembling boards: in which state it is called *board-coal*. This flattened form of substances originally cylindrical, as the trunks and branches of trees, is observable in the *furturbrand*, or bituminous wood of Iceland, as well as in the Bovey coal: and also in other similar situations: and the observation extends to all organic remains met with in strata of clay, or argillaceous schist: for these are constantly of a flattened form, even in the case of bone and shells: so that the same substances, which in a calcareous stratum preserve for instance their original cylindrical figure, in a stratum of argillaceous schistus are compressed into a plane triangular surface."

COMMON OR PIT COAL, *Bitumen lithanthrax*.

Specific characters, opaque, black, brittle, burning with a blackish or grey smoke, and leaving black or grey ashes and cinders.

Pit-coal is usually found in strata in the earth, almost always in mountains of schistus or grit. It appears to be a general opinion, that this substance owes its origin to the decomposition of vegetable bodies. And, indeed, when we attend to the inflammable substances found in the earth, or in the mineral kingdom, we may perceive that very few, and most probably none, of them, can be truly said to belong to it, but have been elaborated in the bodies of animals or vegetables.

getables. From the turf that is pared from the surface of the earth, and owes its inflammability to the roots of vegetables which are mixed with it, we may descend to the peat, or black earth of the moors, in many specimens of which vegetable remains are still perceptible; though in most they appear to be deprived of every appearance of their organic texture, their oily and inflammable nature only remaining; and from thence the transition to pit-coal is easy. For, if we reflect on the vast revolutions which the earth has certainly undergone through a long course of ages, by means of which its surface has been broken, displaced, and inverted, from the actions of floods, earthquakes, and the great convulsions of nature occasioned by volcanic eruptions, it will be no improbable inference that the thin though extensive strata of pit-coal, as well as the exsudations of naphtha, petroleum, and their modifications, have all arisen from the burying of extensive woody tracts of the surface, such as are common in all uncultivated countries. And this probability will be reduced to more certainty, when we advert to the natural history of pit-coal, which is met with in all the various states of transformation. Whole trees are converted into pit-coal, in such quantities together as to exhibit entire forests; in which the roots, trunks, branches, bark, and even species, are discernible. Both coal-pits and slate-quarries exhibit innumerable marks of impressions of leaves, and other indications of their vegetable origin; and the analysis of this combustible substance tends still further to confirm this truth. On the other hand, if we attend to such inferences as chemical theory might point out from the facts around us, we shall see how small the probability is, that the mineral kingdom should, after a certain limited time, contain inflammable bodies, if they were not occasionally thrown into it, in consequence of the operations carried on within organized substances. For all inflammable substances,

substances, tending to decompose the oxygen or vital air of the atmosphere, would, in process of time, revert to the class of un inflammable bodies, if the operation of organized substances, particularly of the vegetable kind, did not tend to disengage the vital air again, and render bodies combustible, which were not so when they became parts of those substances. Thus, as Dr. Kidd observes, "the natural transition of vegetable matter into a substance completely resembling coal, both in external and chemical characters, may be traced by the most gradual and satisfactory steps. A similar conversion of the one into the other may be effected also by artificial processes: and I have seen specimens, the results of Mr. Hatchett's interesting experiments, which in their appearance so closely resembled common coal, that no eye, however experienced, could detect the difference; although the difference between their present and their original form was much greater than between that of common coal and vegetable matter in general: this will be readily admitted upon stating that some of the specimens in question were nothing more than an altered state of *colourless vegetable oils*. There is no absurdity therefore in supposing that coal in general may have been derived from the gradual alteration of vegetable matter. In almost all the coal indeed of Staffordshire and the inland counties, as also in the coal of Monmouthshire and Glamorganshire, the traces of a vegetable origin are so obvious, that those even who are ignorant of the foregoing facts, and totally unprepared or even absolutely indisposed to admit this close relation between the mineral and vegetable kingdoms, must be convinced from the mere appearance, that there is the strongest ground for believing this kind of coal at least to have been derived from vegetable matter; but, as to coal in general, it must be confessed, that the situations in which the strata are found, and most of the circumstances connected with their geological

logical history, present such perplexing appearances, that it seems impossible to expect a consistent explanation of the manner in which the accumulation of these masses originally took place."

Veins of coal are often mentioned by different writers; yet in reality coal is scarcely ever found in *veins*, but rather in *beds* or in *heaps*; though these beds, from a derangement caused by the occurrence of stone or matter of a different kind from that which forms the strata, are sometimes thrown into the form of a horse-shoe, with the curvature downwards, and thus assume the appearance of a vein. When a coal-mine is discovered, its *direction*, that is, its extent in the same horizontal line, and its *dip* and *rise*, or *inclination*, that is, its fall beneath that line, are next to be traced; as it should always be worked at right angles with its direction, and the shaft to drain off the water should be sunk in the lowest part. To find the inclination, three holes, each reaching to the bed of coal, are bored at the distance of six hundred feet from each other, forming an equilateral triangle; and the level and depth of each are taken. The highest is the standard to which the distance downwards of the bed of coal under each hole is referred, that which is most distant in depth from the standard being the lowest. It is almost needless to add, that the boring should be skilfully conducted, in order that the holes be perfectly perpendicular. The tools or instruments used in boring are very simple. The boring-rods are made of iron from three to four feet long, and about one inch and a half square, with a screw at each end, by which they are screwed together, and other rods added as the whole increases in depth. The chissel is about eighteen inches long, and two and a half broad at the end, which being screwed on at the lower end of the rods, and a piece of timber put through an eye at the upper end, they are prepared for work. The operation is performed by lifting them up a little, and letting

ting them fall again, at the same time turning them round, by a continuance of which motions, a round hole is worn through the hardest strata. When the chissel is blunt, it is taken out, and a scooped instrument called a *wimble* put on in its stead; by which the dust or pulverized matter which was worn off the stratum in the last operation is brought up. By this substance, the borers know exactly the nature of the stratum they are boring in; and, by any alteration in the working of the rods, they perceive the least variation of the strata. The principal part of the art depends upon keeping the hole clean, and observing every variation of the strata with care and attention.

In England, beds of coal of less than two feet and an half in thickness are judged not worth working; but in Germany, none exceeding six inches are neglected. To convey a fuller idea of the strata of earth or stone that generally accompany coal-mines, we shall here add Mr. Kirwan's account of those that are found in the principal coal-mines of Europe.

The most considerable coal-mines in England are found in the counties of Northumberland and Durham on the east, and those of Lancashire and Cumberland on the west; they seem to extend across the kingdom, or at least to the mountains of Cumberland and Westmoreland. On the eastern coast, towards Newcastle, the land gently descends towards the sea, but is here and there intersected with deep valleys, in the declivities of which the coaly strata appear to have been first discovered. The principal bed of coal at Newcastle is about thirty-seven fathoms deep: at Whitehaven about sixty.

At Alfreton common, in Derbyshire, the principal bed of coal is a hundred and eighty-four feet deep, buried under strata of argillaceous earth with one seam of coal about half way down, only eighteen inches

inches thick; but the stratum at the bottom is seven feet four inches, of exceeding good coal.

At Hetruria, in Staffordshire, the coal lies very near the surface. The first approach is through ratchil, or fragments of stone; then limestone about one foot thick; a bed of sand, clay, and lime, follows; and then comes the stratum of coal.

At Bagelt, in North Wales, the mine penetrates through sixty-one feet of sand and gravel, shale, clay, and slate, when it reaches a stratum of coal six feet in thickness. It then sinks fifty-three feet deeper, and reaches a seam of coal only two feet three inches thick. But, after descending one hundred and five feet further, through sand-stone and slate, and two hundred and forty feet from the surface, it approaches a stratum of valuable coal, upwards of fifteen feet thick.

At Litchfield, the mine sinks through black clay, rotten-stone, marl, thin coal, black-rock, black-bat, or marl, white-rock, grey-rock, &c. until it reaches a hundred and fifteen feet under ground, where the great and valuable stratum of coal lies, not less than thirty feet thick.

At Colebrook Dale, in Shropshire, according to Mr. Young's Annals of Agriculture, they obtain four strata of coal in the same pit, ranging in the following order; brick-clay, potter's-clay, smut, blue-bat, or marl, sand-stone, coal four feet thick; potter's-clay, then the best coal three feet thick; brick-clay, then clod-coal two feet six inches thick; common clay, and then flint-coal four feet thick. The utmost depth of this mine is only eighty-two feet.

In Scotland, at Baldo near Falkirk, the pit sinks only fifty-two feet under ground, through a thin layer of clay, then a ledge of slate thirty-three feet thick, then limestone, slate, and earth, until it reaches a seam of coal three feet six inches thick.

The most remarkable coal-work ever known, was that

that wrought at Burrowstounness, under the sea. The strata of coal were found to continue under the bed of the sea in this place, and the colliers had the courage to work the seam near half-way over; there being a mote half a mile from the shore, where there was an entry that went down into the coal-pit, under the sea. This was made into a round key or mote, built so as to keep out the sea, which flowed there twelve feet. Here the coals were laid, and a ship of that draught of water could lay her side to the mote, and take in her lading. This famous colliery belonged to the Earl of Kincardine's family. The fresh water which sprung from the bottom and sides of the coal-pit, was always drawn out upon the shore by an engine, moved by water, that drew it forty fathoms. This coal-pit continued to be wrought many years, to the great profit of the owners, and the wonder of all that saw it: but, at last, an unexpected high tide drowned the whole at once; the labourers had not time to escape, but perished in it.

In Ireland, at Drumglass, the mine is a hundred and thirty-two feet deep, passing through clay and rubble-stones, soft argillaceous stone, indurated clay, a ledge of slate, then the seam of coal four feet five inches thick.—At Ballycastle, the other Irish mine, the seam of coal at present worked is five feet thick, but lies two hundred and forty-two feet under ground, passing through strata of basaltes, slate, yellow free-stone, slaty coal, and ninety feet of hard grey free-stone. This mine, notwithstanding, is worked with great spirit.

In France, a quick-burning volatile coal has been discovered, and worked, for many centuries. The best are found in Forez, Bourbonnois, and Auvergne. It lies at considerable depths, and generally in heaps, not in seams, on the sides of hills, and is therefore easily extracted.

In Germany, the strata of coal is very thin, and
3 S 2
found

found at a considerable depth : yet that indefatigable people find it their interest, as hinted before, to work such thin seams of coal as in England are despised. In the Sophia shaft or pit, at Wetten, in the duchy of Magdeburg, the principal bed of coal is only one foot thick, and lies a hundred and eighty-seven feet below the surface, under immense rocks of slate, sand-stone, flint, and shistus. In the Dorothea mine at Lobegin, the seam of coal is four feet five inches thick, and lies a hundred and eighteen feet below the surface, surmounted by yellow clay mixed with calcareous earth, grey micaceous slate, soap-rock mixed with quartz and flint, and bituminous shistus. In the country of Liege, the coal is constantly surmounted by a hard argillaceous grit or sand-stone, and lies in the form of a horse-shoe. The coal mine of Kladraw, in Bohemia, is but six fathoms under the turf, and covered wholly with a white micaceous sand.

In Sweden, the coal is very thin, but generally easy to work. At Boscrupt, in Scania, the mine is fifty feet deep, with a bed of pyritous coal at the bottom, two feet thick. It has also, a little more than half-way down, a seam of coal one foot thick, which is carefully wrought. The superincumbent matters are mostly sand-stone, with argillaceous earths, quartz, and iron-ore. The mine near Helfinburgh has a seam of coal two feet thick, and only thirty-six feet below the surface; and about eighteen feet farther down, it has another seam of coal one foot thick. These strata are principally surmounted by argillaceous slate, and sand-stone.

In Italy, there are no coal-mines; the great line of this valuable fuel appearing to sweep away round the globe from north-east to south-west; not ranging at a distance even from the south-easterly parts of our own island, as hath been generally imagined, but actually visiting Brabant and France, and yet avoiding Italy.

Hence

Hence we may observe, that coals, though not an exclusive, may with truth be styled a peculiar, blessing to this island, as well from their great plenty, as from their acknowledged excellence, and their superiority over all others yet known for fusing metals, and for all manufactures wherein a strong and lasting heat is required. It has been doubted whether the aboriginal Britons, or the Romans who conquered them, first explored this source of wealth in England. But Mr. Whitaker, in his History of Manchester, seems clearly to have shown, that these mines were first opened by the labour of the Britons, long before the era of the Roman invasion. We have no certain account of the use of pit-coal in London earlier than the year 1305, when such of the traders as required much fuel first began to use it in their various avocations; against which practice several of the nobility complained to the king, as being a public nuisance. A commission of enquiry into the grounds of this complaint was ordered by Edward I. in consequence of which a proclamation was issued, under certain pains and penalties, against all those who should in future make use of pit-coal. This will appear a matter of much less surprise, when we reflect that London, in those early times, was every way surrounded with woods; that fuel was in great plenty; and the carriage thereof, both by land and water, remarkably cheap. However, as these woods came gradually to be grubbed up, and converted into arable land, and wood and turf fuel in less plenty, the London manufacturers found they were obliged to make use of pit-coal, notwithstanding the above prohibition, which in 1379 was entirely done away by Richard II. who, in lieu of it, imposed a duty of sixpence per ton each quarter of a-year, upon all ships from Newcastle laden with coal.

It does not appear that the inhabitants of Newcastle-upon-Tyne had any traffic in coal, or any authority to

to open mines, before the charter of King John, which was confirmed to them by his son Henry III. in 1234; and wherein he gives "the said honest men, (*probi homines*), upon their supplication, licence to dig coals in the common soil, without the walls, called the Castle-moor, and to convert them to their own profit, in aid of their fee farm-rent of one hundred pounds per annum." But, in 1357, Edward III. went much further in favour of Newcastle-upon-Tyne, by absolutely granting to the burghesses of that town, the Castle-moor and Castle-field, for the purpose of digging coal, stone, and slate, for their own use and benefit. Yet it does not appear that they exported much coal, though they sent some coastwise, and into the port of London. There certainly was no duty laid on this natural product of our soil, until 1379, by Richard II. of sixpence per ton each quarter of a year, which is recorded in Rymer's *Fœdera*. However, in 1421, the exportation or foreign consumption of Newcastle coal must have been very considerable, since by 9 Hen. V. c. 10, it is enacted, "That whereas there is a custom payable to the king of two-pence per chaldron on all coals sold to people not franchised, in the port of Newcastle-upon-Tyne; and whereas, the keels or lighters which carry the coals from the land to the ships in that port, ought to be of the just portage of twenty chaldron, according to which burden the custom aforesaid is paid; yet, many now making their keels to hold twenty-two or twenty-three chaldrons, the king is thereby defrauded of his due. Wherefore it is now enacted, that all keels (or lighters) be measured by commissioners, to be appointed by the king, and to be marked of what portage they be, under the pain of forfeiting all the said keels (or lighters) which shall be found not marked." This duty, though it might appear trivial to us, was certainly a heavy tax at the time it was laid, when we consider the relative price of coals. Even in
1536,

1536, according to Stowe's Survey of London, coals at Newcastle were sold at only two shillings and sixpence per chaldron, which, brought to London, might produce about four or five shillings. There is, indeed, about this period, frequent mention of *a load of coals* at twelve shillings; but this, Bishop Fleetwood, in his *Chronicum Preciosum*, assures us, is to be understood of charcoal, and not of pit-coal. In 1590, it is stated by Strype, and other authors, "that, by reason of a combination at Newcastle-upon-Tyne, coals were raised in London to the excessive price of nine shillings per chaldron; whereas the usual price, for several preceding years, was but four shillings. Nevertheless, in 1615, the Newcastle coal-trade was so considerable, as to employ four hundred sail of ships, two hundred for the port of London, and two hundred for the rest of England; the French ships came also in fleets of fifty together, from the ports of Picardy, Normandy, Bretagne, Rochelle, Bourdeaux, &c. and the ships of Bremen, Embden, Holland, and Zealand, to purchase Newcastle coal from the pit's mouth.

In time of peace, the different foreign ports receive annually from Great Britain nearly the following quantities, in Newcastle chaldrons, as calculated by Mr. Beaumont, in his treatise on the coal trade:

Holland	-	-	-	-	-	50,000
France and Flanders	-	-	-	-	-	20,000
Denmark	-	-	-	-	-	10,000
Hamburgh	-	-	-	-	-	10,000
Sweden and Portugal	-	-	-	-	-	5,000
Russia, Norway, and ports not mentioned	-	-	-	-	-	5,000

Newcastle chaldrons	-	100,000
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Coal is the fuel used in the Dutch provinces for every purpose; and, although the importation of them from England is attended with so considerable an expence,

pence, yet the Dutch government impose a further duty on British coal equal to seven shillings and four pence per ton for domestic use, and six shillings and three halfpence for those used in their manufactories, amounting nearly to twenty shillings additional impost for every Newcastle chaldron. This fact shows the great importance of the British coal to the Dutch consumers, when they can afford, over and above the prime cost, to pay a revenue of nearly fifty thousand pounds annually to the states!

The principal manufactories carried on in the Dutch provinces with English coal, are, the distillery, sugar-baking, and smiths' work. For the two former, they prefer a strong hot coal, of a lasting quality, and not too small, but with a good mixture of round; for the smiths' use in all countries the strongest small; and for domestic use, as in England. France requires British coal for the use of smiths, and sugar-baking; and Flanders for distilleries, &c. In Denmark they use our coal chiefly for the sugar-houses, smiths, and lime-works; for the latter a considerable quantity, and for that purpose they prefer a hot brisk fire, such coal being of great consequence in burning their lime. Hamburgh uses English coal for the sugar-baking, and smiths' work, as the former. Portugal for founderies and smiths' use. Sweden for her distilleries; which, much increasing, with their smiths' work, will make their consumption more considerable. Russia has a few cargoes to work their engines; but, from establishments at this time forming there, probably more of our coal will soon be required. Norway, and the ports not particularized, use the coal for their smitheries, &c.

The quantity of coal exported from Scotland into foreign countries, is not very considerable. Holland, and the ports in the Baltic, are their marts, and some to the light-houses; and from these ports they return loaded; from the Baltic always with a full cargo,

cargo, and from Holland in great part. They send into England about twenty thousand tons and chaldrons together. Their internal consumption is very considerable, and will soon be as much more, by the iron-works established in different parts of the country.

From what has been premised, Mr. Beaumont goes on to state the propriety, as well as equity, of putting the same impost on all other rivers where coal is navigated, as that originally put on the river Tyne. Soon after coal came into use in London, a tax of twopence on the Newcastle chaldron was laid upon all coals shipped from the river Tyne, at that time the only river in England from which any coal was shipped; the produce, however, was so trifling, that government, at first, did not think it worth collecting. But, after some years, a demand of arrears was made upon the parties, who, in consideration of that claim being dispensed with, agreed for the future to pay one shilling per chaldron; an offer which government readily accepted, and which was afterwards made a perpetual grant to the Duke of Richmond. It is evident, that, when the coal-trade took place in other parts of the kingdom, this tax became a partial one; because coal is admitted to be shipped from all other rivers free from this impost. The produce of one shilling per chaldron, levied on the Tyne, amounted in 1783, to 17,999*l.* 13*s.* and as, by calculation, the proportion of coal shipped from Newcastle constitutes one-third of the quantity shipped in the kingdom, this tax, if made general, would increase the revenue at that time, to upwards of thirty-six thousand pounds per annum; but from the increased demand for coal since that period, it is estimated at fifty thousand pounds per annum at the least. And, as the government lately purchased this grant from the Duke of Richmond, it is probable that an equalization of the duty will shortly take place.

Our abundant supply of coal may truly and emphatically

emphatically be styled, the golden-mine and bulwark of Great Britain; not only as it affords an endless supply of wealth, but because it is an extensive nursery for excellent seamen, from which source our navy has often been made effective on a short notice, when other means have failed.

In working coal-mines, their regularity is frequently interrupted, and the strata broken, by chasms, breaches, or fissures, which are differently denominated according to their various dimensions, and the matters with which they are filled; but usually called dikes, hitches, and troubles. Another inconvenience is that kind of combustible vapour, or inflammable air, which will catch fire at a candle. It proceeds from the dikes or fissures of the solid strata, exhaling from some in an insensible manner, whilst from others it blows with as great impetuosity as a pair of bellows. When this mephitic air is permitted to accumulate, it becomes dangerous by taking fire, and burning or destroying the workmen, and sometimes by its explosion will blow the works out of the pit, and do considerable damage. If a supply of fresh air is forced down the pit by air-boxes and a ventilator, or by dividing the pit into two by a close partition of deals from top to bottom, it will be driven out, or so weakened, that it will be of no dangerous consequence; or, when the mephitic air is very strong, it may be safely carried off by making a close sheathing or lining of thin deals, quite round the circumference of the pit, or by one or two small leaden pipes carried from the sheathing to the surface. If a candle be applied to the orifice of the pipe at the surface, the mephitic air will instantly take fire, and continue burning with a lambent flame until it be extinguished by some external cause.

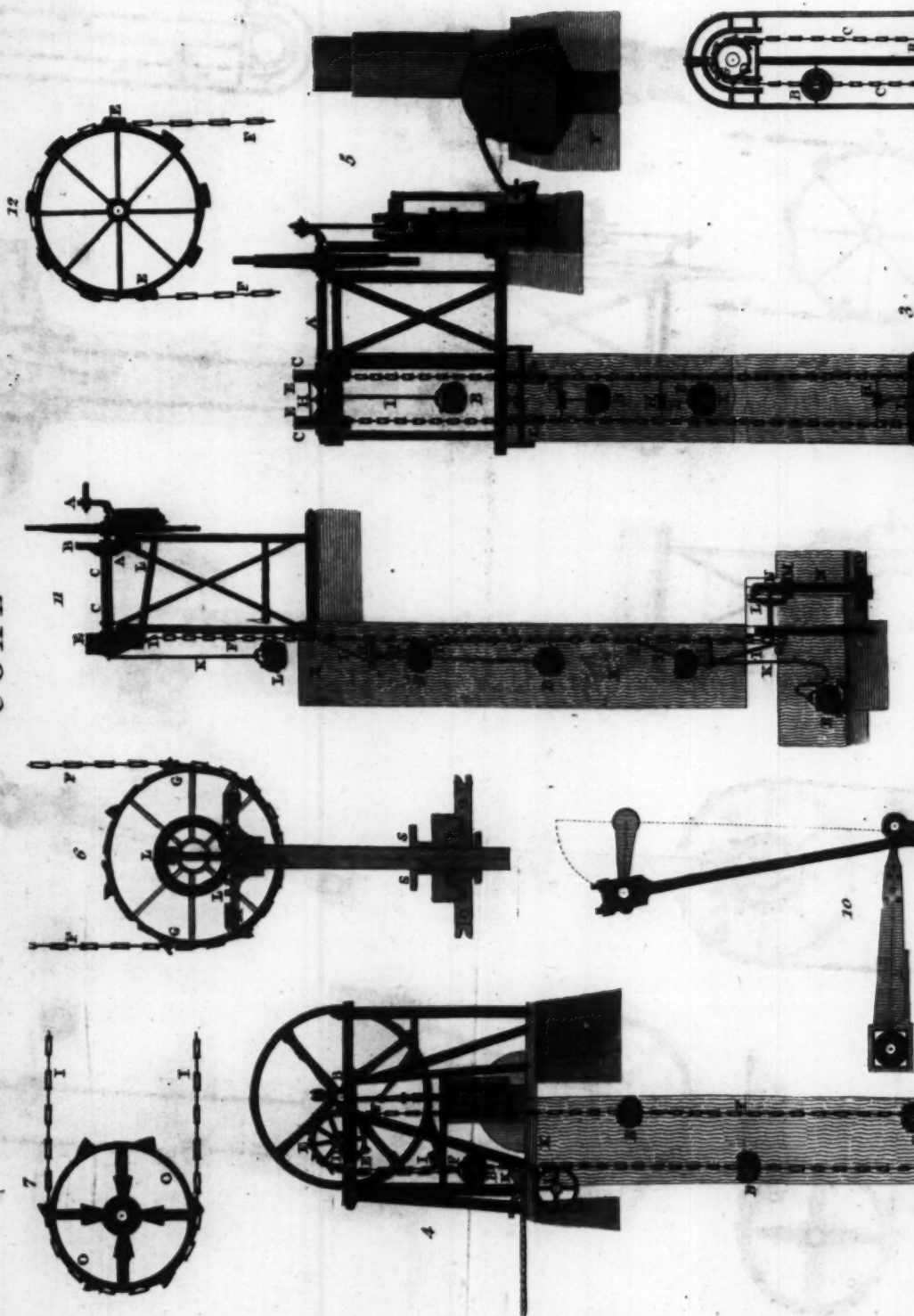
After the pit is sunk to the coal, the next consideration is the mode of working it. The most general practice

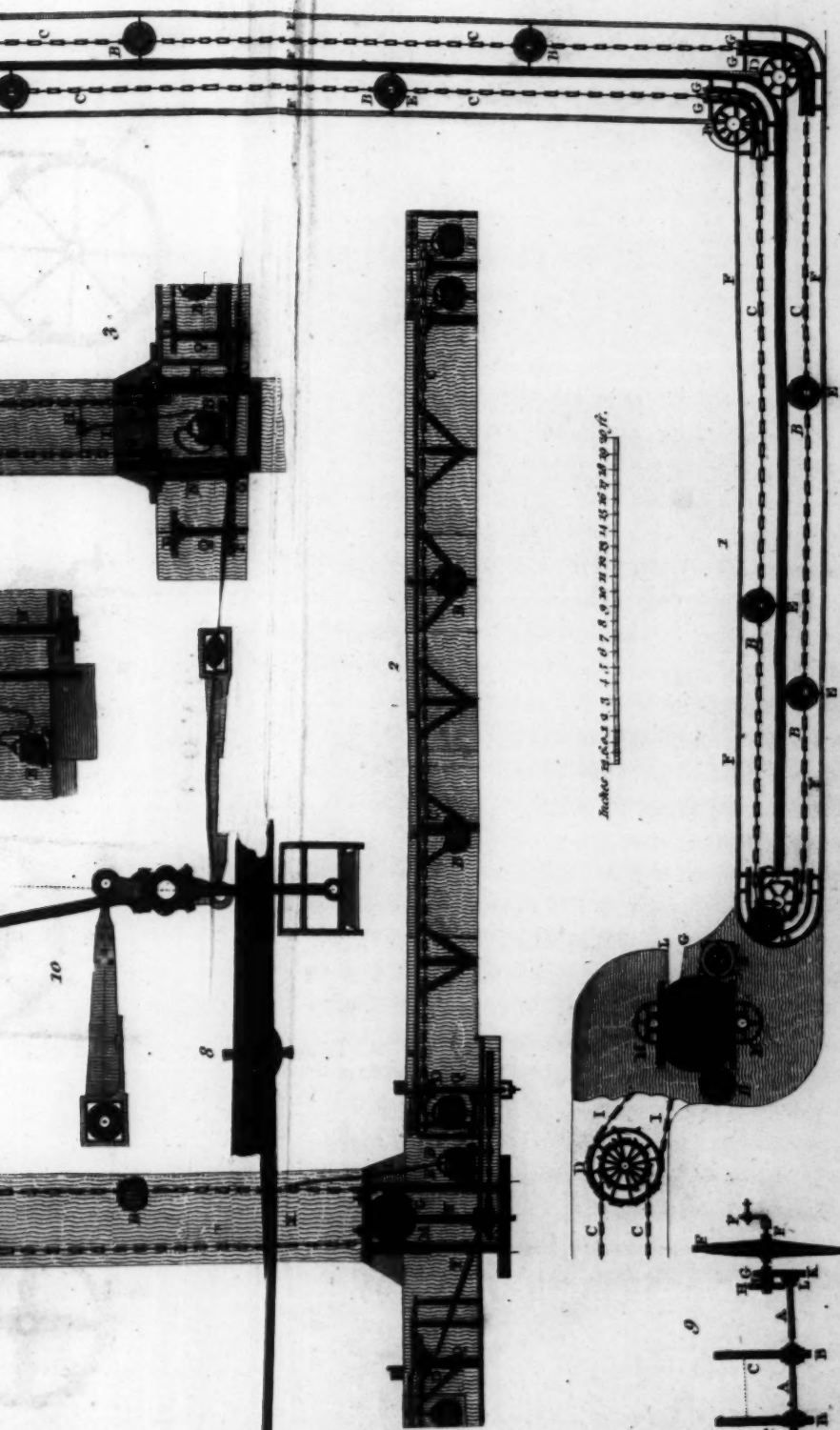
practice is to excavate and take away a part only of the stratum of coal in the first working, leaving the other part as pillars for supporting the roof; and, after the coal is wrought in this manner to such a distance from the pit as intended, then these pillars, or so many of them as may be deemed safe, are taken out by a second working, and the roof and other solid strata above permitted to fall down and fill up the excavation. The quantity of coal wrought away, and the size of the pillars left in the first working, are proportioned to the hardness and strength of the coal and other strata adjacent, compared with the incumbent weight of the superior strata. If there be two or three strata or seams of coal in the same pit, having only a stratum of a few feet thick betwixt them, it is then material to observe, that every pillar in the second seam be placed immediately below one in the first, and every pillar in the third seam below one in the second; and in such a situation the upper stratum of coal ought to be first wrought, or else all the three together; for it would be unsafe to work the lower one first, lest the roof should break, and bury the work and men in one promiscuous ruin.

When the coals are wrought, they are put in baskets, hooked to a chain, and drawn up the pit by a rope to the surface, which is best effected by a machine called a *gin*, worked at present by horses. There are other machines for drawing coals, some wrought by water, others by the vibrating lever of a fire-engine; but those wrought by horses are in most general use. A very ingenious and much improved method of raising coals, has however been lately invented by Mr. Humphrey Jeffreys, engineer, at Newcastle-upon-Tyne. His method has the sanction of the king's letters patent, dated Feb. 12, 1799; the description of which, elucidated by an engraving, we shall give in his own words, viz. "I the said Humphrey Jeffreys do hereby declare, that my said inven-

tion is set forth in the following description; that is to say: My addition to, and improvement of, machinery applicable to the bringing or conveying coals, ores, or other minerals, from the interior or innermost parts of coal-mines, commonly called *putting*, is shown in the annexed plate; where fig. 1. is a ground-plan of this method of putting, represented as placed in the interior part of a coal-mine, where (and also in all the other figures the same letters correspond to the same parts) X X is the pit or shaft. B, B, are full and empty corves, or baskets, for conveying the coal. C C, in an endless chain, or rope, passing round, and supported by, the wheels D, D, are cross bars, supporting the endless chain C C, at certain distances, between the wheels D, D, and from which the corves or baskets, are suspended, as shown in fig. 2. On these cross-bars are four small wheels or pulleys, two of which are placed at the ends of each bar, and bear upon the platform F F, excepting when passing round the wheels D, D, when the inner wheels or pulleys bear on the platform G G; by which means, the corves or baskets B, B, are carried to the opposite side of the platform F F, and then travel in a direction, contrary to that in which they moved on the other side of the platform. By this method of constructing the platform G G, and placing the wheels D, D, (as represented in fig. 1. and 2.) the corves or baskets may be carried round any part of a circle, not exceeding three-fourths, with certainty and expedition, without the assistance of human strength, or retarding the motion of the machinery, which may be worked in the mine by any given power. My method of giving motion to this machinery, is represented in fig. 4, 5, and 11, where the endless chain or chains F, F, being put in motion, (in the manner hereafter described,) and turning the wheels G, G, near the bottom of the pit, (as represented in fig. 4, 5, and 11,) give motion to the wheels L, L, and likewise to the

COAL





Machine for winding coal mines.

Improved Machinery for working Coal-mines.

London: Published at the New Street, opposite the Theatre Royal, by J. H. B. 1810.

2. Plate 1.

the wheels M, M, with their axes N, N. On the same axes are the wheels O, O, and revolve with them; and, by means of the short chain I, I, communicate motion to the wheels P, P, with their axes Q, Q, and the upper wheels, on the same axes D, D. This, of course, gives motion to the long endless chain C C, together with the cross bars E, E, and the full and empty corves B, B, which are thus carried, in rotation, to and from the interior parts of the mine, and the bottom of the pit or shaft.

Fig. 2 and 3 are side-views or sections, representing the interior part of a coal-mine, with part of the pit or shaft, where the same letters refer to the same parts.

Fig. 6, 7, and 8, are an example of this method of communicating motion from the endless chains or ropes F, F, that are represented in fig. 4 and 5; where the wheels L, L, give motion to the wheels M, M, with their axes N, N, and the lower chain-wheels O, O, which communicate motion to the short endless chain I I, together with the wheels P, P, before described. By this contrivance, the machinery may be stopped, or put in motion, as occasion may require, without stopping or retarding the endless chains F, F, when drawing coals up the pit or shaft, as described in fig. 4, 5, and 11.

Fig. 6, is a section of this method of stopping and giving motion to the short endless chain I I, which communicates motion to the endless chain C C. The wheels M, M, being put in motion, with their axes N, N, which revolve in the centre of the wheels O, O, carry round the cylindrical block or chuck S S, with its projections, by means of a prominence in the cylindrical hole of the block, fig. 8, which slides in a groove near the bottom end of the axis N N. This block is suspended as occasion requires, by the lever T, fig. 2, and is thereby prevented from coming into contact with the wheels O, O. When it is found

found convenient to have the endless chain C C put in motion, by the communicating chain I I, a man lifts up the long end of lever T, and depresses the cylindrical block, until it comes in contact with the notches in the wheels O, O, which are then carried round by the projections on the block S S, fig. 8, and the axis N N, together with the endless chains I I and C C. This motion may be stopped at pleasure, by pressing down the long end of the lever T, which lifts the block S S clear from the notches in the wheels O, O; by which means the machinery in the interior parts of the mine is managed with certainty and expedition.

Fig. 4 and 5, represent my addition to, and improvement in, the manner of delivering coals, ores, &c. at the mouth of the pit, where A A is a shaft or axis, worked by a steam-engine, as expressed in the annexed engraving at Y, or by some other power, on which are fixed two wheels working into the wheels C, C, which may be made to revolve either on or with their own axis D. These wheels, in their motion, carry round with them what I term the chain-wheels E, E, and which have projections on their surface, to prevent the chains from slipping. F, F, are endless chains, or ropes, supported by the wheels E, E, and are put in motion by them. These chains are kept in their proper position, at the bottom of the pit, by the wheels G, G. H, H, are cross bars, fixed to the endless chains, or ropes, F, F, for which the corves or baskets B, B, are suspended, by means of short chains or ropes, I, I. The endless chains, or ropes, being put in motion, as above described, and as many loaded corves or baskets being in the act of ascending up the pit, at the same time, as may be found convenient, when the cross bars H, H, come in contact with the chain-wheels E, E, they vary their motion from the perpendicular direction, and are carried over the top

top of the wheels E, E; then, acquiring a descending motion on the opposite side of the wheels E, E, and consequently on the opposite side of the pit, carry with them the loaded baskets suspended as before mentioned, which, in their perpendicular descent, are deposited on the sledge K, as in fig 4. The loaded corves being then disengaged from the small chains, or ropes, I, I, empty corves or baskets are hung on in their stead, and are carried, by the same descending motion, to the bottom of the pit, where they are again disengaged, and full baskets hung on; by which means a regular succession of full and empty corves or baskets is constantly produced.

Fig. 5, is a side-view of this method of delivering coals, ores, &c. at the mouth of the pit, where the same letters refer to the same parts. The wheels L, L, which I call, *conducting wheels*, are placed near the top of the pit, immediately under the platform, which is commonly called the *settle-boards*, and which is on the same side of the pit with the descending side of the endless chain F F. These wheels, being fixed as above described, press against the endless chain F F, and cause that part of the endless chain which comes from the wheels C, C, to the wheels L, L, to alter its perpendicular direction; but, on passing these wheels, it again acquires a perpendicular direction in the pit. The descending side of the endless chain F F being thus pressed nearer the ascending side, and the settle-boards fixed, with the sledge K placed on them, as described in the annexed engraving, the corves or baskets B, B, suspended to the cross-bars H, H, and descending from the wheels E, E, in a perpendicular direction, are deposited on the sledge K.

Fig. 9, is a plan of another method of giving motion to the wheels C, C, and chain-wheels E, E, as expressed in fig. 4 and 5, from the steam-engine Y, or any other given power; where F F is a crank and wheel, with its axis, on which are the wheels G and H,

H, connected together by the cylindrical box or chuck I, which gives motion to the pinion-wheels K and L, with their axes A A, and pinion-wheels B B, together with the wheels C C. The motion being thus communicated by the axis F F, and the wheel G working into the pinion-wheel K, on the axis A A, and such motion being properly adapted to drawing coals, ores, &c. out of pits of great depth, where many corves or baskets are in the act of ascending at the same time, (as in fig. 4, 5, and 11,) the motion thus produced, requires more time than is found convenient for the man, when ascending the pit or shaft; therefore it is necessary to accelerate the motion, which may be done with expedition, by shifting the pinion-wheel K on the axis A A, out of the wheel G, on the crank-axis F F, and putting the small pinion-wheel L to come in contact with the wheel H, on the crank-axis. By this method the chains and machinery, from the crank-axis F F, may be accelerated, in a short time, to any degree of motion that is most convenient; the first moving cause proceeding, without increased velocity.

Fig. 10, represents an example of a method of applying a parallel joint to a crank, by which contrivance, the reciprocating steam-engine may be worked without what is commonly called a beam, and a rotative motion may be communicated to any machinery, as in fig. 4 and 5, where it is applied to drawing coals by the steam-engine. My addition to, and improvement of, machinery for raising coals, ores, &c. out of mines, consists in a method of applying one endless chain, or rope, instead of two; and of this machinery, whereby a considerable saving is made, as well in the first expence of machinery as in upholding the same, and likewise of room in the pit, as is more fully explained in the engraving.

Fig. 11, is a profile of the machinery of this addition and improvement, for raising coals, ores, &c.

out

out of pits or mines, where the same letters refer to the same parts. A, unites with a wheel, worked by a steam-engine, or any other power, and which communicates motion to the wheel B, with its axis C C, and the cylindrical barrel or wheel D. On this barrel are projections E E, to prevent from slipping the endless chain or rope F F, which is carried round and supported by it. G G, is a chain-wheel, placed near the bottom of the pit, by which the endless chain, or rope, is kept in its proper position, and which, at the same time, may be applied to give motion to the machinery for putting, as already described, and expressed both here and in fig 1, 2, and 3. H, H, are bars, projecting from the endless chain F F, and supported by it, and by what I call the brace-chains, or ropes, I, I, which are fastened to the endless chain. These brace-chains or ropes alternately support, in their ascent and descent, the projecting bars H, H, to which are suspended the full and empty corves or baskets B B, by means of the short chains, or ropes, K, K. One end of these short chains, or ropes, is hung on the outer end of these projecting bars, and close to the brace-chains or ropes, in a manner that will admit the projecting bars to revolve within the end of these short chains, or ropes, when the projecting bars come in contact with the cylindrical barrel or wheel D, and the chain-wheel G G. The endless chain F F, with the brace-chains I, I, and the projecting bars H, H, being put in motion, revolve with the cylindrical barrel or wheel D, which causes the corves or baskets, suspended from the extreme end of the projecting bars, as before described, to ascend and descend; and they are carried from one side of the pit to the other alternately, but are prevented from revolving with the cylindrical barrel or wheel D, and the chain-wheel G G, by the ends of the projecting bars extending beyond the end of the barrel or wheel D, while the projecting bars are in contact, and re-

volve with it; consequently, the short chains, or ropes, K, K, by which the corves are suspended, cannot come in contact or revolve with the wheels D and G, but are carried from one side of the pit to the other, in front of the barrel or wheel D, and are kept clear of it, and its axis, by the ends of the projecting bars extending beyond the end of the barrel, as before mentioned; by this means the baskets preserve their perpendicular direction, and are deposited on the sledge K, (which of course is on the descending side of the endless chain F F,) in the same manner as was before explained in fig. 5. L, in fig. 11, is a lever to apply friction, by means of human strength, to the cylindrical barrel or wheel D, for the purpose of stopping or retarding the motion of the endless chain, when required.

Fig. 12, is a profile, taken from the projecting end of the cylindrical barrel or wheel D, and part of the endless chain F, as in fig. 4, (consequently the length of the cylinder of the wheel is invisible,) which is represented on the wheel D, and between its projections E E, by which it is kept from slipping, when a superior weight is suspended to one side of the chain."

When the coals are thus produced from the mine, they are conveyed in coal-waggon's down sloping ways constructed for the purpose, and measured by Newcastle chaldrons into the ships, or else into keels or lighters, by which they are carried to the coal-vessels. The keel of coals is estimated at twenty-one tons and four hundred weight, and contains eight Newcastle chaldrons; so that each chaldron is fifty-three hundred weight. Yet a London chaldron contains no more than thirty-six heaped Winchester bushels, weighing only on an average $28\frac{1}{2}$ cwt. according to the quality of the coal; which weights being nearly in the ratio of eight to fifteen, it is always reckoned that eight Newcastle chaldrons, or a keel of coals, make fifteen London chaldrons. How it came to pass that the same

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word at Newcastle and London, should denote such different quantities, we know not; but both these chaldrons, as well in weight as measure, are settled by act of parliament.

KILKENNY COAL, *B. oxygenatum*.

Opake, black, very brittle, not staining the fingers, burning with little or no smoke or flame, or flaming with iridescent colours, leaving a very small quantity of whitish ashes. There are two varieties:

1. *Stone-coal*; of a slaty texture and conchoidal fracture, with a glassy internal lustre. 2. *Culm*; of a fibrous texture and rather conchoidal fracture, with less internal lustre, and often intermixed with powdered carbon. Both sorts occur in various parts of Wales, particularly round Swansea, and in Ireland, in strata and veins like common coal. It burns very slowly, with great heat, without flame, or with purple, yellow, and white, iridescent colours, and is ignited with much difficulty: during combustion it emits faint suffocating vapours like charcoal, and is therefore dangerous to use in small close rooms: while burning, it explodes and flies about. Culm is considerably contaminated with powdered carbon, which may be easily rubbed off, and then it does not stain the fingers: it contains near 80 per cent. of pure carbon. Stone-coal is principally used for malting; and culm for burning lime.

MELLITES, MELLILITE.

GENERIC characters, soft, brittle, pellucid, shining with a glassy lustre, of a conchoidal texture and honey-yellow colour: in the form of a double four-sided pyramid with the faces quite smooth. There is but one species, called

MELLITE OF ALUMINE, or HONEY-STONE,
M. Wernerii.

Found near Artum in Saxony, between the layers of wood-coal, and in Swisserland imbedded in asphalt; in colour, texture, and transparency, resembling the honey-yellow amber, from which it principally differs in crystallizing in small double four-sided pyramids, whose angles are often truncated: when heated it whitens, and burns in the open air without odour, and without being sensibly charred, leaving a white residuum, which at first has no taste, but at length leaves an acid impression on the tongue: fracture conchoidal or indeterminate. Specific gravity 1.666. Discovered by Werner.

SUCCINUM, AMBER.

GENERIC characters, lightish, yellow, generally transparent, shining internally, of a conchoidal fracture, tough and brittle; when rubbed or heated, fragrant, and strongly attracting straws and light bodies: yielding by distillation succinic acid. But one species is known.

COMMON AMBER, *Succinum electricum.*

The electric property of amber must be familiar to every one. It is the substance in which the property was first discovered, and the term *electricity* has been derived from one of its Latin names. The appearances and electric property of amber are so often alluded to in ancient authors, that it is not necessary to show by quotations that they were familiar with the substance: and, though the history of its origin is much involved in fable, yet they seem to have had some idea that it was found in the north of Europe. Solinus says, that it was originally brought from the northern sea, through Pannonia and Illyria, into the country bordering on the river Po: and hence Phaë-

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ton's sisters, or the poplars of that river, are fabled to have wept amber: this substance being easily mistaken for a vegetable gum. Indeed the insects visible in many specimens of amber sufficiently prove that it was once in a fluid state; but specimens of this kind are not always natural; at least if it is correctly asserted, that the art of softening amber, and introducing extraneous substances, is sometimes practised.

Could amber be dissolved without impairing its transparency, the art of embalming might possibly be carried to a great height by it, if we could preserve the human corpse in a transparent case of amber, as the bodies of flies, spiders, grasshoppers, &c. are to a great perfection. Something of a substitute of this kind we have in fine rosin; which being dissolved by heat, and the bodies of small animals several times dipped in it, they are thus coated with colophony, which in some degree resembles amber.

Amber is principally of two colours, white and yellow. The white is the most esteemed for medicinal purposes, as being the most odoriferous, and containing the greatest quantity of volatile salt; though the yellow is most valued by those who manufacture beads and other toys with it, by reason of its transparency. Amber is the basis of the fine black varnish.

Amber of the finest kind has been found in England. It is frequently thrown on the shores of Yorkshire and many other places, and found even in our clay-pits; the pits dug for tile-clay between Tyburn and Kensington Gravel-pits, and that behind St. George's Hospital at Hyde-park corner, have afforded fine specimens. Poland, Silesia, and Bohemia, are famous for the amber dug up there at this time. Germany affords great quantities of amber, as well dug up from the bowels of the earth as tossed about on the shores of the sea and rivers there. Saxony, Misnia, and Sweden, and many other places in this tract of Europe,

Europe, abound with it. Denmark has afforded, at different times, several quantities of fossil amber; and the shores of the Baltic abound with it. But the countries lying on the Baltic afford it in the greatest abundance of all; and of these the most plentiful country is Prussia, and the next is Pomerania. Prussia was, as early as the times of Theodoric the Goth, famous for amber; for, this substance coming into great repute with this prince, some natives of Prussia, who were about his court, offered their service to go to their own country, where that substance, they said, was produced, and bring back great stores of it. They accordingly did so; and from this time Prussia had the honour to be called the Country of Amber, instead of Italy, which had before undeservedly that title. This article alone brings his Prussian majesty a revenue of 26,000 dollars annually. The amber of Prussia is not only found on the sea-coasts, but in digging; and, though that of Pomerania is generally brought from the shores, yet people who dig, on different occasions, in the very heart of the country, constantly find amber. In the mines where it is found, the upper surface is composed of sand, under which is a stratum of loam, and under this a bed of wood, partly entire, but chiefly mouldered or changed into a bituminous substance. Under the wood is a stratum of vitriolic or rather aluminous mineral, in which the amber is found. Strong sulphureous exhalations are often perceived in the pits.

Amber is distinguished from the preceding mineral called *mellilite* in possessing the electric property to a much more remarkable extent: besides which, *mellilite* has a double refracting property, which amber has not. Amber may be distinguished from gum copal, which it often closely resembles, by the following mark: gum copal, during its combustion, is constantly falling in drops; which amber does not. Specific gravity, little more than water.

AMBRA,

AMBRA, AMBERGRIS.

FLOATING on water, without lustre, opaque, of a granular texture, soft like wax, and sticking to the teeth; highly fragrant, without particular taste; melting in the heat of boiling water; burning easily with a white flame and grey smoke, and entirely consuming.

COMMON AMBERGRIS, *Ambra maritima*.

From the observations and conclusions of Dr. Swediaur, it appears beyond doubt, that this substance is nothing more than the excrements of the *Physeter macrocephalus*, or spermaceti whale, as it is very frequently met with in its intestines, and most commonly mixed with the beaks of the *Sepia octopoda*, or cuttlefish, which this whale is known to feed upon. In a system of Mineralogy, therefore, this substance is evidently misplaced. See vol. ix. p. 110—112.

VEGETABLE AMBERGRIS, *Ambra cuma*.

Magellan mentions an undoubted vegetable ambergris, gathered from a tree growing in Guiana, and called *cuma*. Specimens of this were presented to him by Mr. Aublet, author of the *Histoire de la Guyane*, published in 1774, who himself collected it on the spot: and Mr. Magellan presented part of it to the late Dr. Fothergill, and also to Dr. Combe. It is of a whitish brown colour, with a yellowish shade; melts and burns like wax on the fire, but is rather of a more powdery consistence than any ambergris he had seen.

Pennant, in his *View of Hindoostan*, published in 1798, informs us, that large quantities of ambergris are found floating near the Luccadive Isles, opposite Tellicherry, which he supposes to be a mineral production which oozes into the sea; and that, being sometimes swallowed by the whales, it disagrees with them, forms a concretion in the intestinal canal, and acts as
a flow

a slow poison, bringing on a decay, and finally death. He says that Hamilton mentions a piece of ambergris, in the possession of a certain rajah, valued at 1250*l.* sterling; and that a Capt. Coffin, engaged in the southern whale fishery, found in a female spermaceti whale 360 ounces of ambergris, which he sold for nineteen shillings and nine-pence an ounce.

In Asia, and part of Africa, ambergris is not only used as a medicine and as a perfume, but considerable use is also made of it in cookery, by adding it to several dishes as a spice. A great quantity of it is also constantly bought by the pilgrims who travel to Mecca; probably to offer it there, and make use of it in fumigations, in the same manner as frankincense is used in catholic countries.

GRAPHITES, BLACK LEAD.

CONSISTING principally of carbon, with a little, iron and generally a little silice or alumine: when pure, burns with a reddish flame, emitting beautiful sparks and a smell of sulphur, and leaving little residuum. Black, opaque, very soft; feels somewhat greasy, and stains the fingers; brittle, breaking into indeterminate fragments.—Three species are noted, though probably they are only varieties: we shall therefore confine ourselves to

COMMON BLACK LEAD, *Graphites plumbago*.

Of a metallic lustre and stony structure. Found in different parts of Great Britain, particularly near Dumfries in Scotland, at Barrowdale and Keswick in Cumberland; in Greenland and various parts of the continent. Colour blackish or iron-grey, bluish-grey when cut, with a slight metallic lustre: yields to the impression of the nail, and makes a black mark on paper: texture compact, with a fine grain, and rather a little flexible: it is chiefly used for making black-lead pencils, for blackening stoves, and, when mixed

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mixed with a proper proportion of filex for crucibles: specific gravity 2; contains, when pure, carbon 90, iron 10.

This substance is by M. Haüy classed among the ores of iron. According to its analysis it corresponds very closely with Kilkenny coal. It is called *carburet of iron*, from its component parts, carbon and iron. It very closely resembles the metallic ore called sulphuret of molybdena; but, if both be rubbed on a piece of white porcelain, it will be seen that the streak made by the plumbago is of the same colour with the substance by which it was made; while that made by the molybdena has a distinctly green shade. It may be distinguished from black crayon by the difference of the streaks made by the two substances on paper: the colour of that made by black crayon is a deep dull black; that of plumbago has somewhat of a metallic lustre.

SULPHUR, SULPHUR, OR BRIMSTONE.

YELLOW with a shade of green, hard, brittle, becoming electric by friction, insoluble in water: melting and becoming liquid in a low heat, burning with a blue flame, and intolerably-suffocating vapours which discharge most vegetable colours; in a higher and continued heat, evaporating in the form of vapours: combining with most metals.

NATIVE SULPHUR OR BRIMSTONE, *S. nativum*.

Pure in an uncombined state. Found in a state of solution in the numerous sulphur-waters of Europe, and sometimes deposited in a state of powder in the drains through which they run; in a solid state in the mines of Sicily and Naples, &c. contaminated with arsenic in the neighbourhood of volcanoes, and crystallized in tables, cubes, four-sided prisms longitudinally and very finely striate, simple three or six sided pyramids, or most commonly in double four-sided pyramids in Italy, Spain, Normandy, and Siberia. It is generally found in small pieces of gypsum, layers

of clay, or in lime: lustre a little greasy, and causes double refraction. It does not dissolve in water, but is soluble in fat oils and alkalies: specific gravity 2; consists entirely of sulphuric acid and oxygen.

SULPHURET of POTASH, *S. hepaticum*.

Combined with lime or potash, which it leaves behind after deflagration, smelling like rotten eggs either spontaneously or when acids are poured on it. Found in a state of solution in all sulphur-waters, and is easily detected by its disagreeable smell and taste, and by its readily tarnishing silver, and becoming milky with acids and black with acetit of lead; it is also, though rarely, found in a state of powder at the bottom of lakes. Colour brown, not unlike the liver of animals, but becoming green and even white when exposed to the air; its taste is acid, caustic, and bitter, and it leaves a brown stain on the skin; it converts vegetable blues to green, and soon destroys them: when exposed to a violent heat, the sulphur sublimes, and leaves behind the potash or soda in a pure state.

Sulphuret of potash has the property of decomposing atmospherical air. Put two or three bits of the sulphuret, as big as a pea, into a retort, which fill with water, taking care to slope it so as to let all the air which might be in the globular part pass into the neck; stop the orifice with your finger, and put its neck downwards into the pneumatic cistern, to let in the gas for trial in the ordinary way. By inclining it again, with care, different ways, all the water will be displaced, and the sulphuret remain in the bulb. This done, place the retort in a vertical position, insert the end of it into a glass tube under water, and put a small lighted taper under the bulb. The first impression of the heat dilates the gaseous fluid; and, as the sulphuret begins to bubble up, the water rises rapidly; and, if the air is pure, there is a total absorption; if it be common air, only a certain quantity of water

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water rises into the retort, which represents exactly the volume absorbed.

SULPHUR PYRITES, OR SULPHAT OF IRON, *S. pyrites.*

Intimately combined with iron, with a metallic splendour, of a straw-yellow colour, and common form. Found in every part of the globe, occurring in almost every rock and vein, or forming masses or veins of itself: hard, frequently mouldering and losing its metallic splendour, opaque, brittle, melting with difficulty, and sometimes attracted by the magnet: frequently containing copper, arsenic, or alumine; breaking into indeterminate fragments of a somewhat radiated texture, or compact with a polished reflecting surface, and gradually passing into the crystallized state: not soluble in muriatic acid, but decomposing when in contact with air and moisture, and producing heat and sulphuric acid: like the following species, strikes fire with steel: it consists of iron ore mineralized by sulphur: specific gravity from 3.440 to 4.789.

SULPHURET OF IRON, *S. marcasita.*

Intimately combined with iron, with a metallic splendour, of a gold-yellow colour, in the form of crystals. Found very commonly among coals and shistose rocks, and in mines: it was formerly cut and polished by lapidaries, and shaped into buttons and other ornaments.

CLASS IV. METALS.

METALLIC substances occur in a variety of forms; the most remarkable of which are the following: native metals; metallic oxyds; metallic sulphurets; and metallic salts.

In what is called their *native* state, they possess those properties on account of which they are principally

pally valuable; as malleability, hardness, and splendour. It frequently happens that two or more are intimately blended in the same mass; and when this is the case, the combination is called a *native metallic alloy*.

Metallic oxyds are a combination of the pure metallic substance with oxygen, or that part of atmospherical air which supports the process of combustion and of respiration. A metallic oxyd was formerly called a *metallic calx*. Metallic oxyds are in general of an earthy texture; or, if they possess the splendour and appearance of metals, they are almost always destitute of their tenacity; and are reduced to powder upon the application of a moderate degree of force, as the blow of a hammer for instance. Their specific gravity is greater than that of earthy substances; but less than that of the metals from whence they are derived.

Metallic sulphurets are chemical combinations of a metal, but more commonly of a metallic oxyd, with sulphur, they frequently have a remarkable degree of splendour, and many of the external characters of a metal; but they are readily reduced to powder. In many instances arsenic is contained as well as sulphur; and the presence of either substance is easily ascertained by means of the blowpipe: the sulphur manifesting itself by its pungent odour and the well-known colour of its flame; the arsenic by a white smoke, and a smell resembling garlic.

A *metallic salt* is a chemical combination of a metallic oxyd with an acid.

The term *metallic ore* is by some applied to those natural forms only which require some chemical process in order to bring them back to their supposed original state; and by this process they are consequently said to be *reduced*; by others it is indiscriminately applied to all the natural forms; and includes therefore

therefore native metallic Substances. In early publications the word is spelt *ewer*.

PLATINUM, PLATINA.

THIS new metal is often called *aurum album*; or white gold, from its great specific gravity, and white colour; but its systematic name is derived from its resemblance, in its native state, to small grains of silver; the word *platina* being a diminutive of *plata*, which in Spanish signifies silver.

The existence of platina was scarcely known in Europe before the year 1740. In its native state it occurs in small apparently-flattened grains of a dull silvery lustre, and in general about the size of a small pin's head; mixed with minute particles of magnetic iron, gold, and quartz. It is, besides, alloyed with several metallic substances: some of which possess characters that distinguish them from all other metallic substances hitherto known.

It is not probable that platina exists in its ores in the same form as it comes to us, but that its granular or plated figure is produced by the motion of the waters by which it is carried from the mountains to the plains; that found in the largest grains or lumps is most valuable. It has been sometimes found in masses of considerable magnitude; the society of Biscay possesses one of the size of a pigeon's egg. As it is found in the neighbourhood of gold mines, it is always mixed with a quantity of this metal. The mercury it contains is part of that used in extracting the gold.

The first person who paid any particular attention to platina, was a Spanish mathematician, Don Antonio Ulloa, who accompanied the French academicians in the celebrated expedition to Peru, for determining the figure of the earth. This philosopher gives a cursory account of it in the relation of his voyage, published at Madrid in 1748. Charles Wood,

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an English metallurgist, brought a quantity of this métal from Jamaica in 1741, which he afterwards examined, and gave an account of his experiments in the Philosophical Transactions for 1749 and 1750: at this era, the greatest chemists in Europe appeared emulous in their inquiries respecting this new metal, which promised, by its singular properties, such considerable advantages. Scheffer, a Swedish chemist, published his experiments on platina in the Memoirs of the Academy of Stockholm for 1752. Dr. Lewis made a connected and almost-complete series of experiments on this metal, which may be found in the Philosophical Transactions for 1754. Margraaf has inserted, in the Memoirs of the Academy of Berlin for 1757, an account of his experiments on this new metal. Most of these memoirs were collected by Morin, in a work entitled *La Platina, l'Or blanc, ou le huitième Métal; Paris, 1758*. At the same time Macquer and Beaumé made, in conjunction, a great number of important experiments on platina, which were published in the Memoirs of the Academy for 1758. The scarcity of platina, and the difficulties attending the experiments made on it, stopped for a time the progress of inquiries, but within the last few years they have been resumed with new spirit. Bergman, Achard, and Morveau, have exerted themselves in the examination of the properties of this metal. Guyton has lately published remarks on the gangue of this metal; he found some grains adhering to feld-spar, which makes it to be presumed, that the platina had been loosened by a flood, and washed down as an auriferous sand.

M. Vauquelin has lately discovered the existence of platina in a silver ore from Spain; into the composition of which it enters in the proportion of one tenth. With the exception of this single instance, platina has only yet been found in the gold-mines of America; near Choco in Peru, and at Santa-Fe near Carthagena.

Carthagena. The particular places of Choco where it is found are Novita and Citara. The miners, discovering at an early period that it was a metal, had begun to employ it in adulterating their gold; and the court of Spain, it is said, dreading the consequences, took measures not only to prevent its exportation, but partly to conceal the knowledge of it from the world; for it is reported in the *Annales de Chimie* for 1792, that the gold, when brought from Choco to be coined at Santa Fe, undergoes a new examination, the platina that remains is carefully separated, and, being given to officers appointed by the king, they, as soon as a certain quantity is collected, carry it away, and before witnesses throw it into the river Bogota, at two leagues distance from Santa Fe.

The colour of platina, when properly refined, is something between that of iron and silver; it has no smell, and is the heaviest body yet known in nature, its specific gravity being to that of water as 22 to 1, whereas gold is only as $19\frac{1}{3}$ to 1. It may likewise be said to be the most durable of all metals; it is harder than iron; it undergoes no alteration in the air, and fire alone does not appear to possess the power of changing it; for which reason it forms the very best material for crucibles that has ever been tried. It resists the action of acids, alkalies, and sulphurs: it may be rolled with plates as fine as the gold-leaf used in gilding. It is likewise extremely ductile; and Dr. Withering tells us, that a wire of platina is stronger than one of gold or silver of the same thickness. It is preferable to gold by the property it has of soldering or welding without mixture; and it unites, says Chaptal, two qualities never before met with in one and the same substance—when formed into a mirror, it reflects but one image, at the same time that it is as unchangeable as a mirror of glass.

As this metal, then, possesses so many valuable qualities, it is to be hoped the court of Spain will lay aside

aside its stupid narrow policy, and revoke the decree which has been passed against it; and that the Spanish government will neither despise so rich a treasure as its mines of platina, nor refuse to the world the numerous advantages which may be derived from a substance that promises to be of so much importance in commerce and the arts.

Platina may be obtained in plates and in wire, and may be worked like gold and silver. There are several ways of purifying this metal: 1. By the magnet, which separates the iron. 2. By washing, which carries off the sand. 3. By acids. The methods most usually employed to make it pure and malleable are as follow: 1. Take equal parts of crude platina, oxyd of arsenic, and acidulated tartrit of potash, or potash only. Put the mixture into a well-luted crucible, and expose it for an hour to a violent heat; the platina melts; but it is brittle, fragile, and whiter than ordinary; expose it to a strong heat under the muffle, by which means all the arsenic is driven off, and the platina remains pure. 2. Take three parts of platina, six of oxyd of arsenic, and two of pure potash: throw the mixture into a crucible in several parcels, or by degrees, to promote the oxydation of the iron. Then melt in crucibles with very flat bottoms, that the button may be very thin; thus you have the arsenical alloy. Put the button under the cupel, and heat for thirty hours, to volatilize the arsenic. The operation must be performed with great care and address; if the fire be too strong, it is often necessary to begin afresh: the degree of heat should be just sufficient to volatilize the arsenic without melting the metals; a beginning of fusion makes the arsenic adhere, so that it cannot be driven off. The result of this operation is platina in the spongy form. To render it malleable give it a red heat, put it on an anvil, and give it one good stroke with a hammer; one steady stroke will be sufficient, as a second might make it fly. Then give it a white
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heat, after which about fourscore strokes with a heavy hammer will make it malleable. Vessels are advantageously formed of platina, by pouring a mixture of arsenic and platina into moulds of clay, and exposing the moulds to a heat sufficient to dissipate the arsenic.

The important uses to which this metal may be applied will be easily conceived, when it is considered that it unites the indestructibility of gold to a degree of hardness quite equal to that of iron; that, by itself, it resists the action of the most violent fire, and also of the most concentrated acids. It cannot be doubted but that chemistry and the arts would be in the highest degree benefited by its being applied to useful purposes. Crucibles have been made with platina, and spoons or ladles for assays by the blow-pipe. Conté availed himself of its oxyd as an improvement in enamel-painting; and leaves of platina are advantageously used for plating China-ware or porcelain.

Two parts of platina accurately mixed with one of arsenic and tartar, when exposed to a glow heat in a luted crucible, melt into a brittle substance, still whiter than platina. This substance is easily softened by the fire, or, by a stronger heat, completely melted. In this state, if exposed for a sufficient length of time to the fire, the arsenic is dissipated, and the platina, which again becomes solid, alone remains. Achard has recently taken advantage of this property, to form vessels of all sorts from platina, a substance so insusceptible by itself; a circumstance which seems to lead to further improvements, of infinite importance to society.

During the year 1806, several new and important experiments were made by different chemists on crude platina, from which the most curious results have been obtained.

In endeavouring to discover the cause of the different colours of the triple salts of platina, M. Desco-

tils perceived that the red colour of some of them was owing to the presence of an unknown metal. Fourcroy and Vauquelin, on their part, examined the black powder which remains after dissolving platina; and finding that, in some of their experiments, it exhaled a strong metallic odour, and in others assumed a more fixed form, they were led to regard it as a new metallic substance, the different properties of which they attributed to its different degrees of oxygenation. During this same period, Mr. Tennant examined this black powder, and succeeded in separating it into two methls, one of which was fixed, and the other extremely volatile; while Wollaston discovered that in the solution itself, which was supposed to contain only platina, there was a mixture of two other metals, which not only differed from those which form the black powder, but also from platina itself.

Thus, after having been subjected to a long series of the most accurate experiments during the course of forty years, chemists have succeeded in detaching eleven different metals from this singular mineral, viz. 1. *platina*; 2. *gold*; 3. *silver*; 4. *iron*; 5. *copper*; 6. *chrome*; 7. *titanite*. The two last were discovered by Fourcroy and Vauquelin, in the different coloured sands which are always mixed with it. The two new metals separated from the solution of platina in the nitro-muriatic acid by Mr. Wollaston, are:

8. *Palladium*, a white ductile metal, heavier than silver, very fusible when united with sulphur, soluble in nitric acid, colouring its solution of a beautiful red, precipitable in a metallic state by the sulphat of iron; yielding a dingy green precipitate with the prussiat of pot-ash, forming with soda a triple salt, soluble in alcohol.

9. *Rhodium*, a grey metal, easily reducible, fixed and infusible, imparting a rose-colour to its solutions in acids, which is rendered much deeper by the addition of muriat of tin, precipitated by the alkalies of a yellow

yellow colour, but not at all by the prussiat of potash, the triple salt of which with soda is insoluble in alcohol. The two metals discovered by Mr. Tennant in the black powder after solution are:

10. *Iridium*, a very hard white metal, difficult of fusion, nearly insoluble in the nitro-muriatic acid, and wholly so in all the others; oxydizable, and soluble by the fixed alkalies, the oxyd being soluble in all the acids, and imparting to the different solutions various vivid and lively colours. It is these salts which give the red colour to those of the platina.

11. *Osmium*, a metal hitherto irreducible, the oxyd of which, in the form of a black powder, is extremely volatile, having a strong odour; it is very fusible, dissolves readily in water, exhales with it in the form of vapour, to which it imparts a strong taste and smell. The solution becomes of a blue colour by the addition of the smallest quantity of the tincture of galls.

AURUM, GOLD.

OF a reddish-yellow colour, not tarnished by the air; softish and very tenacious, not sonorous, exceedingly malleable and ductile, specific gravity 19.3: burning in a red heat with a sea-green light, and melting at a white heat. Soluble only in nitro-muriatic acid, and giving the solution a yellow colour: when melted with borax, producing a ruby-coloured glass.

NATIVE GOLD, *Aurum nativum*.

Not combined with other minerals, very ponderous, ductile, visible in its matrix. Found in the sand of a stream flowing from mount Groghan near Arklow in the county of Wicklow, in Ireland; in Cornwall and Scotland; in the mines of Peru and Chili, New Spain, Java, Siberia, Transilvania, Spain, Hungary, France, and most countries of Europe, generally near the surface, or mixed with sand in the beds of rivers: it is rarely found quite pure, but almost al-

ways mixed with silver, copper, or other substances, giving more or less variation to its appearance or colour: its form is generally common, or imbedded in its matrix in various shapes; sometimes it has decussating grooves on its surface, or is cellular or plumose, or resembling teeth, branches, bristles, or hairs: in its crystallized state it is usually in small aggregate six-sided tables with a right-angled four-sided prism ending in a point, or terminated at each end by an imperfect four-sided prism, in cubes, or simple three-sided or double four-sided pyramids. It has no perceptible taste or smell, and does not alter or lose its lustre by any exposure to the air or water. Its malleability is such, that one grain of gold may be beaten so thin as to cover $56\frac{3}{4}$ square inches; an ounce of gold upon silver wire is capable of being extended more than 1300 miles; and so great is its tenacity, that a gold wire 0.078 inch in diameter is able to support a weight of 15 pounds avoirdupois without breaking. The largest lump of native gold known was brought from Wicklow, and weighed 22 ounces.

The author of Lord Anson's Voyage says, that gold was first discovered in Brasil about the year 1710, in the mountains which lie adjacent to the city of Rio Janeiro: the most common account of its discovery is, that the Indians on the back of the Portuguese settlements were observed, by some soldiers there stationed, to make use of this metal for fishing-hooks; and by inquiry it was found to be separated from the sand and gravel deposited in the valleys by torrents from the neighbouring mountains. The author of the voyage saw a large fragment of these rocks, in which a considerable lump of gold was entangled. He says that the slaves, who were employed to collect the gold, were bound to supply their masters with fifty grains a-day, the value of which was equal to about nine shillings. What they collected

collected above fifty grains they had the right of retaining for themselves.

Gold is commonly recovered from the sand containing it by the process of washing: by which, in consequence of the difference in the specific gravity of the two substances, a separation is easily effected: the gold almost immediately subsiding, while the sand is poured off together with the water, that for a time is capable of holding it in suspension. The sand of any river is worth working for the gold it contains, provided, it will yield twenty-four grains in a hundred weight: but the sand of the African rivers often yields sixty-three grains in not more than five pounds weight; which is in the proportion of more than fifty times as much.

In some instances the gold contained in the sand of rivers has been brought down from the mountains where those rivers originate; but this is not always the case; so that those who have traced the current of a river towards its source, with the hope of finding a more abundant supply of gold in that quarter, have often been deceived. In some rivers, indeed, the sand of those parts, which are farther removed from the source, is richer in the gold than the sand of those parts which are nearer; which of itself is almost sufficient to prove that the gold has not in these instances been brought from the mountains. In the case of the Tesino, which flows through one of the lakes in the north of Italy, the quantity of gold in that part of the river which is below the lake is in much greater abundance than in that part of the river which is above the lake; where indeed a very small quantity, if any, is found: but, supposing the gold to have been detached from the mountains near the source, it would hardly have been conveyed through the lake, where the current of the river must necessarily have been much slackened, to be deposited in a

more

more distant part, where the current was much stronger.

But there are strong positive grounds for supposing that the gold found in the sand of many rivers has been derived from the soil surrounding that part of their course where it is met with; for it is found in very circumscribed situations; and the quantity is always greater after violent showers have fallen upon the open country immediately adjoining; and the soil of this adjoining country, if washed, itself affords gold.

Most of the gold of commerce comes from Africa and from South America; and, from various accounts, it appears that alluvial districts afford by far the greatest proportion of this; and that the alluvion in which it is contained is principally a ferruginous sand. The only considerable gold-mines in Europe are those of Hungary.

The gold-mines of Bambouk, in Africa, are a national property, over which the kings, or *tarims*, have no other personal authority than that of watching over and protecting them: the inhabitants work those which are situated within their own territory. The country of Bambouk is, strictly speaking, auriferous earth, says Golberry, but the four principal mines are those of Natakou, Semayla, Nambia, Kombadyrie. The working of the mines is carried on during the eight months of dry weather, and ceases when the rainy season commences. As all the gold is obtained by ablution, those blacks who best understand the method of working it, obtain the greatest quantity of gold. They obtain it by digging pits about six feet in diameter, and varying in depth from thirty to forty feet, the earth is brought up by baskets, taken to a rivulet, and undergoes a thorough ablution: when they have dug about four feet deep, they meet with a flat argillaceous earth, intermingled with small grains of iron ore, of load-stone, and emery, all of which are covered

covered with little particles and spangles of gold. All the rivulets of the valley of Natakön convey gold with their water; the sands and mud which form the bed of them are also full of the same metal; the soil composing the bed of the Colez-Rio-d'Oro produces a considerable quantity of gold, and the whole plain of Natakön. From all these circumstances Mr. Golberry is induced to believe, that the mountains surrounding Natakön contain in their beds and caverns the real gold-mine, while the Monticuli of Natakön itself is nothing more than an emanation from the main body. In the year 1786 Mr. Golberry carried on a small trade for gold at Galam; that which he received was made into ear-rings and other ornaments; it was assayed at Paris in 1788, and it was, according to the account of the assayer, twenty-three carats fine. It was sold at the rate of twelve francs per drachm; and a gold ear-ring from the mine at Natakön, in the form of a heart, of three inches in length, weighing more than seven grains of fine-coloured gold, was examined by M. Sage, professor of mineralogy, and one of the directors of the mint, and discovered to be gold of the purest quality.

Gold is never found in any other than a native state; and is usually alloyed with copper, or silver, or iron: sometimes with all of these. Native gold is separated from the substances accompanying it by means simply mechanical, as pounding and washing; or by fusion with lead; or by the process called amalgamation. These processes are employed previously to the operation of refinement.

The process of *washing*, the principle of which has been already explained, is commonly employed in separating gold from the sand of rivers, &c.

The process by *fusion* with lead is applied principally to the ores of other metals, which contain a sufficient proportion of gold to repay the cost of extraction: these ores are for the most part sulphurets of
of

of copper, &c. but particularly sulphuret of iron, or iron pyrites: and are consequently called *auriferous*. These sulphurets are roasted, or exposed to a sufficient degree of heat to expel most of their sulphur; which operation in a great measure disengages the particles of gold before enveloped in the mass; and then they are melted with lead. The lead combines with the gold, which is recovered by the process of refinement.

The process by *amalgamation* depends on the property which quicksilver possesses of attracting and combining with gold; and is applied either to auriferous metallic sulphurets, or to native gold contained in indurated rocks. In either instance the substances containing the gold are stamped and triturated with quicksilver, the sulphurets however being previously roasted; and during the process the quicksilver absorbs every particle of the gold, loses proportionally its fluidity, and forms that kind of alloy which is called an *amalgam*: the term *amalgam* being applied instead of alloy to a combination of any metal with quicksilver. This amalgam is afterwards washed by a current of water, in order to separate the particles of earthy matter; and a great portion of the quicksilver is separated from the gold by straining it forcibly through linen bags: the gold which remains on the linen is then exposed to a degree of heat sufficient to volatilize every particle of the quicksilver; and the gold itself remains behind, alloyed however in general with silver, and sometimes other metals.

The gold separated by any of the three foregoing processes is afterwards melted with the quantity of lead that has by experience been found necessary, and is submitted to the process of *cuppellation*. This process is so named from the vessel employed to hold the mixture of the lead and gold, called a *coppel* or *cuppel*; it is made of calcined bones, which are powdered, and with the smallest quantity of water possible

possible formed into the appropriate shape: the substance of this is very porous, and on that circumstance in a great measure depends its use.

The use of the lead in the process of cuppellation depends partly on the property which it possesses of being vitrified by the joint action of air and a high degree of heat; and partly on its power of promoting the vitrification of almost all the other metals, except gold or silver. The gold then, together with the lead, being placed on the cuppel, and a strong heat being applied, together with a constant current of atmospheric air, the mass is soon melted; and the lead, being vitrified by the joint action of the heat and air, and vitrifying the base metals with which the native gold was alloyed, sinks in the form of a viscid glass into the substance of the cuppel. For the effectual separation of tin or iron, sulphuret of antimony is used after the lead. By a careful management of this process the lead and all the other metals are separated, and the mass which remains behind consists entirely of the gold, mixed with whatever proportion of silver was originally contained in it. If the separation of the silver is required, the gold, after the completion of the foregoing process, is melted with three times its weight of silver: the mixed mass when consolidated is flattened into laminæ, and boiled in nitric acid; which dissolves the silver, and leaves the gold in a state of purity.

Gold is applied to a great number of uses; its scarcity and price in a great measure prevent its being made into utensils or vessels; but, as its brilliancy and colour are very agreeable, methods have been found of applying it to the surface of a great number of bodies, which it at the same time defends from the impressions of the air. This art, in general called *gilding*, is performed in a variety of methods. Leaves of gold are often applied on wood by means of some glutinous substance. A powder of gold is prepared by tritu-

rating the clippings of gold-leaf with honey, washing the paste with water, and drying the particles of gold which precipitate. *Shell-gold* is an oxyd of gold, mixed with a mucilaginous water, or solution of gum. *Water-gilding* is done by previously cleaning a piece of copper, intended to be gilt, with sand and weak aqua-fortis, called *aqua secunda*, after which the piece is plunged in a diluted solution of mercury; the mercury which precipitates causes the amalgam of gold to adhere, which is spread on the piece, after having washed it with water to carry off the acid; when the amalgam is uniformly spread, the piece is heated on charcoal, to volatilize the mercury, and the work is finished by covering it with gilder's wax, composed of red bole, verdegris, alum, or martial vitriol, incorporated with yellow wax, and heated once more to burn off the wax. The other uses of gold, for toys, laces, &c. are sufficiently known without enumeration. As to the medicinal virtues attributed to gold, it is admitted, by all physicians of reputation, that they are imaginary, and that the effects of the different kinds of potable gold proposed by the alchemists, arise from the substances in which the metal has been mixed or dissolved.

The name of *gold in rags* is given to the following preparation: Very fine clean rags are steeped in a solution of gold, and afterwards dried and burnt in a crucible: the ashes, which are of a dark purple colour, are used to gild small pieces of copper and silver; it is generally rubbed on with a bit of cork, and the gold, being so minutely divided, easily adheres.

It is not necessary to enumerate the other species of gold, which take their names from the substances they are found mixed with; as *arenarium*, that which is combined with sand; *platinatum*, mixed with platina; *argentiferum*, with silver; *molybdeni*, with molybdena; *stibiatum*, with antimony, &c. &c. The species are twelve in all.

ARGENTUM,

ARGENTUM, SILVER.

OF a white colour, not tarnished by the air, hard and tenacious, sonorous, exceedingly malleable and ductile. Melting when perfectly red hot, and its brilliancy much increased. Soluble in nitric acid, giving no colour to the solution, and may be precipitated from it by copper, iron, or zinc.

Silver is a metal highly useful, on account of its ductility, and its indestructibility by fire and by air. Its brilliancy renders it capable of serving the purposes of ornament. It is applied on the surface of different bodies, and even on copper; and likewise enters into the texture of rich silks; but its most considerable use is that of affording a matter, proper, by its hardness and ductility, to form vessels of all sorts. Silver plate is usually alloyed with one twenty-fourth of copper, which gives it a greater degree of hardness and coherence, and does not render it at all noxious, because the twenty-three parts of silver cover the copper, and entirely prevent its noxious effects. It is universally employed as a medium of exchange, in the form of money; in this case it is alloyed with one twelfth part of copper, and is consequently eleven penny-weights fine.

NATIVE OF CAPILLARY SILVER, *A nativum*.

Malleable, ductile, with a metallic splendour internally; totally soluble in nitric acid. Found in various parts of Great-Britain, particularly in the copper-mines of Cornwall; in the mines of Mexico and Peru, and in most of the mines on the continent: it is rarely to be met with quite pure, but most commonly combined with a greater or less proportion of copper, and has sometimes its surface striate: it assumes various forms, and is sometimes found in prisms or cubes. In malleability it yields only to gold, as it may be beaten out into leaves the 160000th part of an inch thick; and

and may be drawn out to so fine a wire, that a single grain can be extended nearly 400 feet in length; its tenacity is likewise such, that a wire 0.078 of an inch in diameter will support 17.813 pounds avoirdupoise without breaking. When melted, if the heat be increased, the liquid metal boils, and will at last be volatilized: when dissolved in nitric acid and precipitated in lime-water, it falls to the bottom in the form of a dark greenish-brown powder: when dissolved in nitric acid and precipitated with mercury, it shoots up in a shrub-like form, and is then called *Arbor Diana*. Its solution is colourless, highly caustic, giving the skin, hair, and almost all animal substances, an indelible black colour; and, when evaporated till a pellicle begins to form on its surface, it deposits on cooling transparent crystals of nitrat of silver, from which is made the caustic material called *lapis infernalis*, or lunar caustic. If its precipitate by lime-water be dried and washed with a solution of pure ammonia, it has a most dangerous fulminating property, exploding most violently on the slightest touch or friction. This powder is denominated *fulminating powder*.

BLACK SILVER, *A. nigrum*.

Deep black, friable, ponderous, effervescing with nitric acid, and recovering at last its metallic splendour when rubbed. Found in the silver-mines of Sicily, Britanny, Saxony, Hungary, and Bohemia, sometimes covering other minerals as with a coating, sometimes interspersed in larger or less particles, not unfrequently in a pulverised state: it commonly contains sulphur, arsenic, and copper, and sometimes a little iron.

MURIAT OF SILVER, or CORNEOUS SILVER, *A. corneum*.

Ponderous, soft, malleable, without metallic lustre, somewhat diaphanous, easily melting in the fire, and evaporating

evaporating at last in a white fetid smoke. Found in the mines of Mexico, Peru, Siberia, Hungary, Bohemia, Saxony, Germany, &c. It melts before a candle like wax or suet, and before the blow-pipe leaves small grains of pure silver; soft, and easily cut with a knife: colour white, grey, yellowish, green, violet, or brown. Sometimes it is found in irregular masses, sometimes in hollow globular pieces, or in thin plates, or in a state of powder, or crystallized in small cubes or in accumulated flakes, or in acicular, rarely capillary, prisms. It melts very easily, becomes purple on exposure to the sun, and has a waxy lustre. The best kind contains about 72 per cent. of silver, which may be extracted by separating the sulphur and decomposing the remainder with soda, which when mixed with it and exposed in a crucible to heat, combines with the acid, and leaves the silver in its pure state; purer, indeed, than it can be obtained by any other means.

AURIFEROUS SILVER, *A. electrum*.

Malleable, ductile, with metallic lustre, yellowish, not wholly soluble in nitric acid. Found in the mountain Schlangenberg in Siberia, and in the mines near Kongberg in Norway, of a yellowish-white colour, or that of pale brass; rarely in solitary masses, but generally disseminated, or filiform, or reticular, or in spangles. A specimen from Norway, examined by Dr. Fordyce, contained silver 72, gold 28. It may be easily separated by dissolving the mass in nitric acid, which decomposes the silver, leaving the gold untouched.

ANTIMONIATED SILVER, *A. stibiatum*.

With a metallic lustre, tin-white, malleable, very hard, lamellar, not emitting sulphuric nor arsenical vapours when burnt; leaving a white oxyd when acted on by nitric acid.

Antimoniated

Antimoniated silver does not often occur. It has been met with near Guadalcanal, in Spain; in the territory of Furstemberg, in Suabia; and near St. Andreasberg, in the Hartz: it is usually in irregular grains or lumps or kidney-form pieces, or crystallized in irregular four, six, or eight, sided prisms, which are striated longitudinally: colour white, texture laminar, fracture conchoidal. Before the blowpipe the antimony evaporates in a grey smoke, and leaves a brownish slag, which tinges borax green: it gives a greyish-black powder, and does not decrepitate when heated: with quicksilver it amalgamates easily without the assistance of heat. It is not soluble in nitro-muriatic acid, but may be dissolved in boiling nitric acid, leaving a residuum of about 27 per cent. Contains, in its purer state, silver 84, antimony 16.

ARSENICAL SILVER, *A. arsenicum*.

With a metallic splendour, easily melting and emitting arsenical vapours. Found in the mines near Andreasburg in Hercynia, sometimes of a steel-white colour and lustre, and containing a little iron, sometimes pale ochre-yellow. Its hardness is often considerable, and then it is fibrous internally; sometimes it is so soft as to be easily cut with a knife, and in curved foliations. Commonly found in round irregular lumps, or crystallized in six-sided prisms or pyramids. Contains silver 12.75, iron 44.25, arsenic 35, antimony 4.

SULPHURET of SILVER, or VITREOUS SILVER,
A. vitreum.

Of a dark bluish-grey colour, easily melting, and emitting during combustion sulphurous flames and vapours; opaque, very ponderous, soft, tenacious. Found in the mines of Siberia, Norway, Saxony, Bohemia, Hungary, Spain, and America, generally superficial, and running like veins through other fossils: colour

colour deep lead-grey, greyish-black, or steel-blue, with very little metallic lustre, and sometimes variegated on the surface. Its appearance is rarely massive, but most commonly in thin plates, granular, capillary, arborescent, or crystallized in cubes or in double four or six sided pyramids: internally it has more of a metallic lustre.

This is the *glaserz*, or glassy ore, of the Germans. The term *glaserz* is supposed to be a corruption of *glanzerz*, or shining ore: for the ore in question has not the least resemblance to any thing like glass, but has frequently a considerable degree of metallic splendour. The English name, *Vitreous silver ore*, is merely a translation of the word *glaserz*. It is the richest of all the ores of silver; not only on account of the proportion of silver contained, 85 per cent. but the ease with which it is reduced. By a well-regulated heat the metallic silver may be made to exude in a curled capillary form: and the sulphuret of silver thus altered is occasionally sold as native silver; some of the most beautiful forms of which it closely resembles. Perhaps in some instances native silver may have been occasionally derived from a similar source. The malleability of this substance, as being a metallic sulphuret, is very remarkable. It receives any impression so accurately, that it has been used for stamping medals.

RED SILVER, *Argentum rubrum*.

Ponderous, red when scraped, a little shining internally, decrepitating in the fire, and afterwards melting with an arsenical smell. Found in various mines of Peru, Chili, France, Spain, Germany, Saxony, Hungary, &c. with arsenic, galena, or other ores of silver, in masses, or disseminated, sometimes stalactitical or botryoidal, or crystallized in small prisms or acicular pyramids, or radiated in a stellate manner. It differs much in degree of transparency, colour, texture, and form: it is friable or brittle, but so soft as to be cut
with

with a knife. When broken it has a glassy appearance, and when scraped with a knife the particles appear scarlet. When heated it crackles, and melts very easily before the blow-pipe, blackening, burning with a blue flame, and giving out a white smoke, with a slight smell of garlic. It becomes electric by friction, but only when insulated; and is soluble in nitric acid without effervescence: it denonates with nitre when thrown into a red-hot crucible, and becomes then capillary silver. It contains silver 56, antimony 16, sulphur 15, oxygen 12, and a little arsenic.

GREY SILVER, *Argentum album*.

Opake, with a metallic lustre, compact, ponderous, of a pale lead-colour externally and when scraped, emitting sulphurous and arsenical vapours when burnt; brittle. Found in the mines of Saxony, Bohemia, Hungary, Sicily, &c. imbedded in quartz, and other minerals: it contains not more than 15 per cent. of silver, the remainder being made up of sulphur, arsenic, copper, and iron, in various proportions. When scraped it exhibits a brighter surface, but of the same colour: it breaks into indeterminate fragments, and is of a flat texture. It is brittle, but so soft as to be cut with a knife.

HYDRARGYRUM, QUICKSILVER.

OF a silvery-white colour, becoming gradually blacker in the air, always in a state of fluidity in the common temperature of the air: evaporating in a low heat: soluble in most acids, and imparting no colour to the solution; when dissolved in muriatic acid and mixed with lime-water, precipitating an orange-red powder.

NATIVE MERCURY, *Hydrargyrum virginicum*.

Pure, fluid, very ponderous, of a silvery colour and lustre. Found in the quicksilver-mines near Sahlberg
in

in Sweden, at Almaden in Spain, Idria in Bohemia, in the Palatinate near Wolfstein and Moersfeld, in the duchy of Deuxponts, and on Mount Stahlberg, &c. in small globules scattered through different kinds of stones, clays, and ores, and may be easily extracted by evaporation.

It was long taken for granted, that mercury could not be deprived of its fluidity; but the academicians of Petersburg proved the contrary. These learned men availed themselves of the excessive cold in the year 1759, to try many important experiments. They increased the natural cold by the assistance of a mixture of snow and fuming spirit of nitre, and by that means succeeded in causing a mercurial thermometer to fall 213 degrees; according to the graduation of De Lisle; which answers to 46 degrees below freezing of the gradation of Reaumur, or—39 of Fahrenheit. These philosophers, observing that at this degree mercury descended no longer, broke the ball of glass, and found the metallic fluid frozen in the form of a solid, which, on trial, proved capable of extension under the hammer. This experiment demonstrated that mercury, like all other metallic substances, is capable of assuming the solid form, and that it is then in a certain degree ductile. They could not determine the degree of ductility it is susceptible of, because every stroke of the hammer, communicating heat to some part of the metal, melted it, and caused it to flow in that point.

Pallas, who succeeded in congealing mercury in the year 1772, at Krasnejark, by the natural cold of 55 degrees and a half, observed that it then resembled soft tin, and was capable of being beat out into plates, that it broke easily, and that the pieces being brought together united again. In 1775, Mr. Hutchins observed the same phenomenon at Albany fort, and Mr. Bieker at Rotterdam in 1776, at the fifty-sixth degree below zero of Reaumur. This congelation was also

effected in 1733, in England, at a more moderate degree of cold; and it was determined that 32 degrees below 0, or zero, of the thermometer of Reaumur, is the term at which this congelation takes place. If therefore the mercury descended lower in the early experiments, the phenomenon must be attributed to the condensation of the solid metal. Hence we see that this metal is the most fusible of any we know. The greatest cold known in the countries from whence it is obtained, cannot render it solid.

There are several processes for extracting the mercury from the ores in which it is contained. The usual way is by taking among the ore, and drawing off the water. Some employ what are called *draining-galleries*. Sometimes the ore is mixed with lime, and distilled in iron retorts: these retorts are immoveably fixed in the furnace; the matter is put in at the neck, and the mercury is received in vessels filled with water. The mercury obtained by distillation is always pure, because it is not then mixed with volatile bodies. Mercury differs from other metallic substances by its fluidity, which has caused it to be esteemed a peculiar metallic water, called *aqua non madesaciens manus*, "water which does not wet the hands."

The mercury met with in commerce is seldom pure, as it is almost always mixed with pewter, or foreign metallic matters, whence it appears tarnished, and, instead of dividing itself into neat globules, it flattens, and seems to be covered with points: the merchants then say it *draws a tail*. When pure, and especially when obtained from cinnabar, which is called *mercury revived from cinnabar*, it possesses an extreme degree of divisibility; and its globules always run into a convex form.

Mercury has no taste that the nerves of the tongue and palate can distinguish, but it produces a very evident effect on the stomach and intestines, as well as on the surface of the skin. Insects and worms are infinitely

deceitful

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more sensible of this taste than other animals, and for that reason it very soon kills them; and physicians administer it as an excellent vermifuge. It is by virtue of this property likewise that it cures the itch, and other cutaneous disorders. Rubbed for a short time between the fingers, it emits a slight peculiar smell. When it is very pure, and is agitated, it is sometimes observed, more especially in hot weather, to shine with a small phosphoric light clearly discernible. This phenomenon has been shown with the mercury of the barometer by several natural philosophers. If the hand be plunged in this metallic fluid, a sensation of cold is perceived, which seems to show that its temperature is much beneath that of the atmospheric air; yet, by plunging a thermometer in the same mercury, it is immediately seen that their temperatures do not differ. This effect, which deceives us, is to be attributed entirely to the great rapidity with which the heat passes from the hand into the mercury; for this metal is known to be a powerful conductor of heat.

Mercury, reduced into vapour, has a very considerable force of expansion, and is capable of producing dangerous explosions when confined. Hellot related to the French Academy, that a certain person, being desirous of fixing mercury, had put a quantity into an iron-ball, well soldered together. The ball being thrown into the middle of a heated furnace, had scarcely become red, when the mercury burst through its confinement with a great report, and escaped. Beaumé, in his Experimental Chemistry, relates a similar fact.

Mercury is of the most extensive use in the arts, such as gilding; silvering of glasses, constructing of meteorological instruments, metallurgy, &c. It is used in medicine in a great variety of forms. Crude mercury was formerly employed in the iliac passion. It is still boiled in water, to which it communicates a vermifuge property. Mixed with fat substances, it

forms an ointment used in venereal disorders. Mercurial water, or its nitric solution, is used by surgeons as a powerful escharotic. All the preparations of mercury, which are internally given, produce very powerful effects in other disorders, as well as those of the venereal kind; such as most disorders of the skin, scrophulous disorders, lymphatic swellings, &c. We cannot, however, forbear observing, that these medicines, more especially the saline mercurial preparations, ought not to be applied but by experienced and cautious physicians; and that it is dangerous to the health, and even to the life, of men, that mercurial remedies should be in the hands of a great number of persons, who, generally speaking, are deficient, not only in the knowledge which is necessary to administer them with success, but even in that knowledge which might enable them to avoid danger.

AMALGAM of MERCURY with SILVER,
H. amalgama.

Ponderous, of a silvery colour and lustre, rather solid, evaporating when heated, and leaving pure silver. Found in the mines of Hungary near Zlana, near Moschellansburg and on the mountain Stahlburg in the duchy of Bipontium, and in Sweden, rarely in large masses, imbedded in quartz, hornstone, or spar, but generally running through other ores of quicksilver, sometimes in imperfect cubes, prisms, or pyramids. Colour silvery-white or grey, sometimes tarnished in an iridescent manner: it is brittle or soft according to the proportion of mercury, but is generally soft enough to bear the impression of the thumb-nail, and when cut with a knife gives a creaking noise: when rubbed on gold, it leaves a white streak. Contains mercury 64, silver 36.

MURIAT

MURIAT OF MERCURY, *H. muriatum.*

Without metallic lustre, subliming almost entirely before the blowpipe, in the form of a white smoke, without sulphurous flame or vapours. Found in the mines of Wolfstein and Moersfeld in the Palatinate, and near Moschellansburg in the duchy of Deuxponts, in scales or grains, or crystallized in small four-sided prisms terminated by four-sided rhomboidal summits, or four-sided pyramids with the angles truncate. Colour smoke-grey, yellowish-grey, yellowish-white, lemon-yellow, or greenish, rarely blackish. The crystals have a pearly lustre, are semi-transparent and soft, and have a foliated texture: when thrown on red-hot charcoal, they discover a smell like garlic, and when mixed with lime-water occasion an orange-coloured precipitate: it consists of mercury combined with sulphuric and muriatic acids in various proportions.

RED OXYD OF MERCURY, *H. larvatum.*

Deep red, of an earthy texture, heavy, subliming its mercury by heat. Found mixed with sand near Alicant in Spain, and in the soil in the mercury-mines of Idria and Buschian, compact and heavy, and is generally mixed with globules of mercury. When heated in a close vessel, it yields oxygen and a little carbonic acid gas, and the mercury becomes recovered. It appears to contain about 0.91 of mercury.

ÆTHIOP'S MINERAL, *H. Æthiops.*

Black, without lustre or transparency, staining the fingers, easily melting, and if the heat be increased entirely subliming with a sulphureous smell and flame. Found in the mines of Nassau near Kirchem, and in those of Idria, generally in a loose powdery state, of a black or greyish-black colour, and accompanied by lamellated cinnabar or sulphur pyrites. It consists of mercury merely mixed with sulphur.

NATIVE

NATIVE CINNABAR, or SULPHURET of QUICK-SILVER, *H. cinnabaris*.

This is called *native cinnabar* by Kirwan, to distinguish it from the artificially-prepared cinnabar, or vermillion. It is the *minium* of Pliny. Specific character, ponderous, without metallic lustre, red, scarlet when scraped, easily melting, dissipating before the blowpipe with a blue flame and sulphurous smell. Found in Peru, Chili, New Spain, Japan, China, Siberia, Hungary, Sicily, Germany, &c. disseminated, in veins, grains, or ramifications, in a matrix of indurated clay, white and ferruginous quartz, calcareous spar, argillaceous shift, or pyrites. Colour, various shades of red, sometimes greyish: the crystals are three or four sided pyramids, single or double three-sided prisms with three-sided pyramids, or six-sided prisms: more or less shining, and of an earthy, lamellar, compact, fibrous, or granular, texture: the softer kinds stain the fingers and make a red mark: it is insoluble in nitric acid, and contains about 80 of mercury and 20 of sulphur.

Cinnabar is frequently the matrix of native quick-silver: it is principally found in the mines of Idria, Deuxponts, and Almaden in Spain. The mines of Spain are the most ancient, and were worked in the time of the Romans. It appears from Vitruvius that the term *minium* was derived from the name of a river in Spain; and there are several passages in Pliny which show that the term *minium* was applied to a substance corresponding with our cinnabar. He says that almost all the *minium* in use at Rome came from Spain; and that the ore was sent over from Spain sealed. The first circumstance shows the abundance in which *minium* was met with in Spain; the last, its value, both are characteristic marks of the cinnabar of the present day. He also says that those who were employed in reducing the *minium* to powder wore loose bladders

bladders over their face, lest they should inhale the dust, the effects of which were very pernicious : this custom is also observed at the present day by those who are employed for a length of time together in triturating preparations of quicksilver. The term cinnabar was originally applied to the drug commonly called *dragon's blood*, which is of a dull red colour : it was afterwards transferred to the ore of quicksilver now under consideration. Sulphuret of quicksilver may easily be reduced by mixing it with quick-lime or iron-filings, and submitting the mass to the process of distillation : the lime or the iron attracts the sulphur, and the quicksilver passes over in a disengaged state. Cinnabar is distinguished from red silver by the red streak it gives when rubbed on paper ; and in being entirely volatilized by heat : from realgar, by the bright red colour of its powder ; the colour of realgar, when pulverized, being yellow : the same mark will distinguish it from chromate of lead : from red cobalt ore, by its more lively red colour ; and in not emitting a smell of garlic, when exposed to the blow-pipe.

HEPATIC MERCURY, *H. hepaticum*.

Ponderous, of a common form, burning with a blue flame, but evaporating only in part. Found in the mines of Idria, and is nothing but cinnabar mixed with indurated clay : colour dark red or liver-brown, greenish, bluish, or lead-colour, or speckled green or blue : texture compact, nearly even, shining and taking a polish, sometimes so soft as to be cut with a knife, and leaves a red mark. It is not soluble in nitric, but easily in muriatic acid.

CUPREOUS MERCURY, *H. cuprifera*.

Dark-grey, of a glassy texture, decrepitating and emitting sulphureous flames when heated, and before the blowpipe leaving a bead of copper. Found in beds
of

of pot-stone, quartz, and shift, in the mines near Moschellandsburg and Sumatra, in a compact brittle heavy state, and of a grey or blackish colour. When fresh broken it has a glassy appearance : it gives a red streak, and before the blowpipe melts with borax into a green glass : it contains more or less of sulphur and copper. There are four more species or combinations of mercury.

CUPRUM, COPPER.

FINE red, easily tarnishing in the air ; hard and tenacious, malleable and ductile, sonorous and elastic ; specific gravity 8.667 : melting with difficulty, and when exposed to a red heat taking fire and emitting a most brilliant green light ; exploding violently when melted and cast into water : soluble in most acids and ammonia, exhibiting a blue colour ; from its solution in nitric acid precipitating a blue oxyd by the addition of potash : tinging glass green.

The word copper, *cuprum*, appears, to be derived from the name of an artificial alloy of this metal, called *æs cyprium* ; which was a compound of copper and tin. In the early natural historians, *æs*, when used simply, very often signifies copper. It is a metal of a red brilliant colour, to which chemists have given the name of Venus, on account of the facility with which it unites to, and becomes changed by, a great number of bodies. It has a disagreeable smell, which is more sensible when it is rubbed or heated ; its taste is styptic and nauseous. It is capable of being reduced into exceedingly thin leaves, or fine wire ; by immersion in water it loses between one-eighth and one-ninth of its weight ; its tenacity is such, that a copper wire of the tenth of an inch in diameter, can sustain a weight of 299 pounds one quarter before it breaks.

The uses of copper are numerous, and well known. As copper is a very violent poison, it ought never to be administered in medicine. The properest remedies

in case of poisoning by copper reduced into oxyd or verdegris, are emetics, abundance of water, alkaline sulphurets, alkalies, &c.

NATIVE COPPER, *Cuprum nativum*.

Native copper is found in Cornwall, Anglesea, Wicklow in Ireland, on the shores of the Copper island near Kamtschatka, in Iceland and the Feroe islands, Hungary, Siberia, Sweden, Norway, and many other parts of the old and new world; in compact masses, plates, threads, and arborescent and botryoidal figures of various forms; sometimes crystallized, in cubes or double four-sided pyramids; texture sometimes granulated, rarely lamellar. Superficial colour, when tarnished, greenish-yellow, or reddish with pale green, bluish or variegated: when hard and compact, it takes a fine polish, and exhibits a rich metallic lustre, but soon tarnishes by the action of the air, and contracts a greenish rust or oxyd, called *verdegris*, which appears to have saline qualities, viz. taste, and solubility in water. From this circumstance the ancient chemists admitted the existence of salt of copper. It is remarkable, that this rust never attacks copper except at the surface, and seems even to contribute to the preservation of the internal parts and masses of this metal, as may be seen in antique medals and statues, which are preserved very well beneath a covering of rust. The antiquarians call this crust *patina*, and set a high value on it, because it shows the antiquity of the pieces which are covered with it. Many artists, and in particular the Italians, know how to imitate this coating, and to counterfeit the antique bronzes.

Chaptal has a memoir on a new mode of manufacturing verdegris. This process, practised at Montpellier for some years past, consists in causing the residue of grapes to ferment, and of putting it in layers between plates of copper, to develop the metallic oxyd, called verdegris. This method is superior to the old one,

as it is much easier, and attended with less expence, because it requires no wine. Experiments of the same chemist prove also that white lead may be made in the same manner.

To reduce the oxyd of copper: Mix scales, or any other oxyd of copper, with soft or black soap; make it into a stiff paste, and a little muriat of soda may be added. Put the mixture into a crucible, and place it in a melting-furnace; heat it gently at first, till the soap burns no longer; then increase the fire rapidly, to give a white heat. Let the crucible cool, break it, and the button of copper will be found.

Mr. Jameſon mentions a maſs of native copper, on the authority of Profeſſor Vandilli, weighing 2600 Portuguese pounds. It is ſaid to have been found in a valley near Cachoeira, in Braſil.

COPPER OCHRE, *C. lateritium*.

Red, ſoft, without metallic luſtre. Found in the mines of Saxony, in compact lumps ſprinkled in ſmall particles. Colour hyacinth red, more or leſs inclining to brown or yellow. Texture generally earthy, rarely imperfectly conchoidal, and often covering other ſoſſils as with a cruſt. It is eaſily pulveriſable, and makes a conſiderable ſtain on paper: when breathed on, gives an earthy ſmell: it often decrepitates and blackens in the fire, and is not totally ſoluble in acids or volatile alkali: it has a greater or leſs mixture of iron, and contains from 30 to 54 per cent. of oxyd of copper.

RED COPPER OCHRE, *C. rubrum*.

Of a dull red or browniſh-red colour, *hardiſh*, without metallic luſtre. Found in the mines of Cornwall, India, Siberia, Hungary, &c. in compact maſſes, of a common, lamellar, or fibrous, texture, and often cryſtallized in cubes, priſms, or pyramids: colour various ſhades of cochineal red, making a bright red ſtreak,

break, and giving a red powder. It decrepitates and turns black in the fire; is soluble in nitric acid with effervescence, and in themuriatic without effervescence; to the nitric acid it gives a green tinge, and a blue one to volatile alkali: it frequently contains nearly 70 per cent. of copper.

HEPATIC COPPER, *C. hepaticum*.

Brown, *soft*, without metallic lustre. Found commonly with the red oxyd in the mines of Sweden, Saxony, Austria, &c. sometimes in an earthy and friable state, sometimes compact and indurated, not unfrequently covering other ores in stalactitical concentric layers: colour greyish, yellowish, or reddish-brown. It sometimes contains a small quantity of silver, and is chiefly composed of oxyd of copper and iron: it yields from as low as 2 to 20 per cent. of copper.

INDURATED COPPER, *C. piccum*.

Black, hardish, without metallic lustre. Found in the mines of Hercynia and Austria, in a lamellar or imperfectly-conchoidal state, or coating copper pyrites: colour brownish black, or dark yellowish brown. It contains a large quantity of iron, and yields only 7 or 8 per cent. of copper.

BLACK COPPER, *C. fuliginosum*.

Black, superficial. Found in the mines of Hungary, Saxony, and Sweden, generally in a friable state, and seems to have been produced by pyritical copper ore, or mundic, which has been decomposed with iron.

MOUNTAIN BLUE, OR ARMENIAN STONE;

C. cæruleum.

Sky-blue, *soft*, without metallic lustre; soluble in acids without effervescence, and giving them a green colour. Found in the mines of Cornwall, Derby-

shire, &c. in Armenia, Siberia, Hungary, Saxony, &c. massive and earthy: colour often verging to green: it is sometimes found in a powdery state, and sometimes investing other ores: contains often copper 69, carbonic acid 29, water 2.

CARBONAT OF COPPER, *C. cuprigo*.

Sky or smalt blue, without metallic lustre, entirely soluble in acids with effervescence, and giving them a green colour. Found in most of the copper-mines of Europe, generally in small granular particles, dispersed through different stones, stalactitical, botryoidal, or crystallized in rhomboidal prisms, with four-sided summits. It leaves a sky-blue trace, and is brittle: before the blowpipe it blackens, and tinges borax green with effervescence: specific gravity 3.608: contains copper 66 to 70, carbonic acid 18 to 20, oxygen 8 to 10, water 2.

MOUNTAIN GREEN, OR MALACHITE, *C. arugo*.

Green, giving a blue colour to ammonia, effervescing with nitric acid, opaque, without metallic lustre. Found in the various copper-mines of Great-Britain, Africa, Siberia, Hungary, Saxony, Bohemia, &c. in solid masses or in small particles interspersed in different matrices, or in various forms, as kidney-shaped, botryoidal, stalactitical, or in concentric layers: colour from a dull to a light apple-green: lustre usually silky: before the blowpipe it decrepitates and blackens, but does not melt, and gives a green colour to the flame: it effervesces with nitric acid, and tinges borax yellowish-green and alkalis blue: a specimen from Siberia contained copper 58, carbonic acid 18, oxygen 12.5, water 11.5. There are four varieties.

Jamieson says, that M. Patrin saw at Petersburg a plate of malachite, about thirty-two inches long and seventeen broad, which was valued at twenty thousand livres. It is used in the arts for ornamental jewellery;

jewellery; and sometimes, when pulverized, as a pigment. In a vein of malachite, in the most eastern part of Siberia, a mineral is met with that has sometimes been mistaken for the emerald, and sometimes for a crystallized variety of the green carbonat of copper. Haüy has given the name of *dioprase* to this mineral in consequence of a peculiar reflexion of light in its interior.

ARSENIAT OF COPPER, *C. arsenicale*.

Dull olive-green, becoming blue with prussiat of potash, emitting arsenical fumes before the blowpipe, and leaving a ductile copper bead. Found in the Carrack mine in Cornwall, and near Jonsback in Silesia, in cliffs of quartz: colour various shades of green, sometimes inclining to brown, generally in transparent crystals of various forms. Specific gravity, from 2.548 to 4.208: a fine specimen contained oxyd of copper 50.62, arsenical acid 45, water 35.

MURIAT OF COPPER, *C. arenaceum*.

Grass-green, soluble in acids without effervescence, burning with green and blue flames when thrown on hot coals. This species of copper has only yet been met with in America; near the confines of Peru and Chili. It occurred first in the form of sand, whence the name *arenaceum*; it has since been met with of a compact texture. The pulverulent form of muriat of copper, called *green sand of Peru*, is found in a small river, which loses itself in a desert that separates Chili from Peru. It was brought into Europe mixed with sand and other earthy particles. The green and blue colours, which it gives to the flame of a candle, sufficiently distinguish it from pulverulent green carbonat of copper: it emits no smell of arsenic upon the application of the blowpipe; and may thus be distinguished from arseniat of copper.

PHOSPHAT

PHOSPHAT of COPPER, *C. phosphoratum*.

Greyish-black externally, emerald-green within, soft, of a divergently-fibrous fracture, opaque. Lately found at Rheinbreidbach near Cologne, in lumps, or dispersed through other minerals, or in minute six-sided clustered crystals: lustre glassy without, silky internally: it makes an apple-green scratch. Contains oxyd of copper 6.813, phosphoric acid 30.95.

WHITE COPPER ORE, *C. albidum*.

Hardish, whitish, with a metallic lustre, emitting arsenical vapours when burnt. Found with other copper ores in the Middleton Lyas veins, and in the mines of Hungary, Siberia, Germany and Saxony, interspersed with other fossils in larger or smaller lumps, and sometimes crystallized in four-sided double pyramids: colour steel or silvery-grey, often reddish brown; powder grey, with sometimes a tinge of red: texture compact, very brittle, and when rubbed emitting the smell of arsenic. It consists of copper, iron, arsenic, sulphur, and sometimes a little silver.

PURPLE COPPER ORE, *C. purpureum*.

Hardish, with metallic lustre, brittle, red or blue. Found in America, Siberia, Lapland, Norway, Saxony, Germany, &c. generally mixed with other ores of copper, in masses, plates, or disseminated: colour copper red, brown, purple, azure, blue or green: streak reddish and metallic: texture conchoidal, brittle: with nitric acid it effervesces and tinges it green, deflagrates with nitre, and melts before the blowpipe with smell, smoke, or vapour: contains copper 58, iron 18, sulphur 19, oxygen 5.

GREY COPPER ORE, *C. cinereum*.

Hardish, brittle, with metallic lustre, compact, of a steel-grey colour. Found in Cornwall, Saxony, Hungary,

gary, Siberia, Germany, &c. sometimes amorphous, sometimes in four-sided crystals with the edges often truncated: colour steel-grey, often tarnished or variegated: streak dark grey, often reddish-brown: powder blackish, with frequently a tinge of red: with nitre it deflagrates, and melts with crackling before the blowpipe: it tinges borax yellowish or brownish-red. Contains, when pure, copper 31.36, sulphur 11.50, antimony 34.09, silver 14.77, iron 3.30, alumine 0.30.

COPPER PYRITES, SULPHURET OF COPPER, OR
MUNDIC, *Cuprum fulvum*.

Yellow, with metallic splendour, emitting sulphurous flames and vapours when thrown on hot coals. The most common ore in the mines of Cornwall, Ireland, Siberia, Hungary, Sweden, &c. in innumerable varieties and proportions, massive, disseminated or crystallized. Colour light-yellow or greenish-yellow, sometimes verging on the steel-grey, when tarnished by the air often variegated with gold-yellow, blue, green, or red. Texture even, or imperfectly conchoidal, rather soft. It deflagrates with nitre, does not effloresce by exposure to the air, nor effervesce with nitrous acid: before the blowpipe it decrepitates, gives a greenish sulphurous smoke, and melts into a black globule which gradually takes the colour of copper: it is composed of copper and sulphur with a little iron: it tinges borax green. It is not in the slightest degree malleable, but yields easily to the file; rarely strikes fire with steel.

Copper pyrites often undergoes a superficial alteration of colour, in consequence of exposure to air; passing through numerous iridescent shades, principally of purple, blue, and red: these afterwards tarnish and become fainter; and at last are blended together into a uniform dull brown or greenish brown colour. It sometimes occurs in a mamillated form: the surface of the tubercles is either very obscurely iridescent,

iridescent, or of a light greenish bronze colour; and here and there incrustated with small irregular crystals of the same nature, but of a bluish-black colour, disposed in the manner of filigree work. The dark colour both of the mamillated masses and of the crystals is only superficial: the interior substance is of a uniform yellow.

Copper pyrites is the ore from which a great proportion of the copper of commerce is obtained. The first part of the process consists in the separation of the sulphur by means of fire, and is technically called *roasting* the ore. This is conducted either in the open air, or in large chambers: combustible materials are mixed with the ore that has been broken down into fragments of a convenient size; and the whole is then piled in heaps, and set on fire. In all instances it is necessary that this process should be repeated three or four times, in consequence of the strong degree of attraction that exists between the sulphur and the metal: in some, ten or twelve times; or even more. The roasted ore is afterwards melted in a furnace; from which it passes into basons placed beneath: in this state it is of a blackish brown colour, and very brittle; containing a less proportion of sulphur than the native ore, but in other respects equally unfit for economical purposes. It is therefore broken up, and again and again fused; the process being frequently repeated as many as six, or eight, or even ten, times. When by these repeated fusions the sulphur has been nearly separated, the copper shows itself in distinct patches diffused through the substance of the imperfectly-reduced mass; sometimes accumulated in very delicate capillary filaments.

But, after all the sulphur has been separated, the copper generally contains some portion of iron, or zinc, or other metals; and these are separated by a process somewhat analogous to the cupellation of gold: for the copper is exposed while in fusion to a constant current

rent of air, which oxydates the other metals. The metallic particles thus oxydated are collected upon the surface of the melted copper, in the form of drops; which is removed from time to time, in order to expose a fresh surface of the liquid metal to the action of the current of air. Indeed the complete reduction of the copper is altogether a very tedious process; and, from the obstinacy with which the sulphur adheres to the metal, it is often a very difficult process also: and this will account for the difference observable in the copper of commerce; which in some instances possesses the metallic character in a much higher degree than in others. Thus it is found that the copper employed in sheathing ships sometimes lasts a much longer time than it does at others. The defect may often be owing to want of attention during the reduction: in some cases it may depend upon the nature of the ore.

When this ore contains a very small proportion of metal, it is often employed for extracting the sulphur principally; which is done by roasting it in chambers communicating with flues, in which the sulphur separated by the heat is collected. The roasted ore is afterwards washed for the purpose of extracting the sulphat of copper that has been formed during the process; the water holding this salt in solution is collected; pieces of iron are thrown into it, on which the copper is precipitated in a metallic form; which being collected is called *cement-copper*, or *copper of cementation*.

BELL-METAL ORE, *C. campanarum*.

Hardish, ponderous, with metallic lustre, of a bluish steel colour. Found in Chili, and in Cornwall near Whealrock; and consists of copper and tin pyrites, with sometimes a little arsenic.

BRASS COPPER ORE, *C. aurichalceum*.

Of the colour and lustre of brass, malleable. Found near the river Laxa in Chili; and consists of copper pyrites, and blende or sulphuret of zink.

GREY SULPHURET OF COPPER, or VITREOUS COPPER ORE, *C. vitratum*.

Soft with metallic lustre, of a lead colour, easily melting before the blowpipe. The origin of the term *vitreous* seems to have arisen in this instance from a similar mistake with that described under the head of sulphuret of silver, or vitreous silver ore, p. 559.

It is very brittle in general: the purer varieties are slightly malleable. Its colour is a dull grey; which by exposure becomes black. Under the blowpipe it leaves a metallic button; which is of a grey colour, in consequence of the iron contained in it. Contains copper 78.50, sulphur 18.50, iron 2.25, flux 0.75.

This is a very rich ore of copper; but not easily reduced, on account of the sulphur contained in it. It is met with principally in Siberia, Sweden, Saxony, and in Cornwall: the last-mentioned place affords the most distinctly crystallized specimens. A considerable quantity of this ore has lately been recovered from the refuse of several old mines in Cornwall, which were worked seventy or eighty years since; the valuable nature of this ore not being known there, at that time.

It is commonly accompanied by yellow sulphuret of copper, or mundic. Grey sulphuret of copper may be distinguished from the discoloured varieties of red copper ore, in not effervescing with nitric acid: from sulphuret of silver, by its brittleness; and by the grey colour of the metallic button which it leaves after the action of the blowpipe.

BITUMINOUS

BITUMINOUS COPPER, OR PITCH ORE,

C. phlogisticum.

Black, burning slowly with a flame, and at last consuming to ashes. Found in Dalecarlia in Sweden, and in Siberia, and resembles a piece of coal or bituminous shist: it consists of bituminous coal or shale impregnated with oxyd of copper: the ore is extracted from the ashes with considerable difficulty.

FERRUM, IRON.

GENERIC characters, Bluish-grey, easily rusting in the air, very hard, tenacious, and elastic, sonorous, exceedingly malleable, ductile, attracted by the magnet and itself convertible into the magnet; specific gravity 7.778: becoming white in the fire, then emitting brilliant sparks, and at last melting; forming a red oxyd when its filings are kept red-hot in an open vessel and stirred: soluble in all acids, giving them an astringent taste and a black colour when mixed with vegetable astringents; precipitating a green powder when dissolved in sulphuric acid and mixed with potash; with the prussic acid producing a rich azure blue.

This metal, called Mars by the alchemists, is very abundant in nature, under different modifications. Various terrestrial substances contain it in the form of grains, which may be extracted; and in a still greater number it is a colouring principle. Pure iron is soft, and soft iron is ductile. *Cast iron* is that which has been separated from its ore, and rendered fusible by a small quantity of charcoal and a certain proportion of oxygen: there are three sorts, black, white, and grey.

Steel is iron, which, after being cast, is become ductile by hammering; then it is made to re-absorb the charcoal it retains, which greatly increases its weight; it acquires another property also, *temper*. The temper does not increase the density of the iron. By

touching steel with an acid, there is a black spot, which is not the case with iron. The process for converting iron into steel, is as follows: Short bars of iron are enclosed in an earthen box or vessel, filled with a cement, commonly composed of very combustible matters, such as soot, or the coal of animal matters, animal oil, to which is usually added, ashes, calcined bones, marine salt, or sal-ammoniac. The box, being well closed, is heated for ten or twelve hours, till the bars become white, and are ready to melt. In this operation the iron becomes purified, and is completely reduced by the assistance of the combustible matters with which it is surrounded; the portions which were not perfectly in the metallic state, assume that state; and the phosphuret of iron, if it still remains, appears to be entirely decomposed. The iron, being softened and dilated, absorbs the charcoal which surrounds it; and hence the *steel of cementation* is nothing else but a combination of pure and well-reduced iron with charcoal. It differs from iron in containing charcoal, and from cast iron in this, that the crude iron contains not only charcoal, but a greater or less quantity of oxygen. If cast iron be deprived of its oxygen without separating the charcoal, or by giving it a new quantity, steel will be produced without refining the iron. Clouet says a 1-32d part of charcoal is sufficient to convert iron into steel. In a quantity equal to one 1-6th of the iron it affords a steel more fusible and still malleable, but beyond this term it approaches to cast iron, and has not a sufficient degree of tenacity. Steel is much more fusible than iron, for which reason the bars which are converted into steel by cementation, are softened to that degree, that the carbonic acid, which is disengaged in bubbles during the action of heat, forms small blisters, or very sensible cavities, on its surface. This kind of steel is called *blister-steel*. The differences of steel depend upon the greater or less reduction of the iron, the quantity

quantity of charcoal which it contains, and the more or less sudden cooling it has been subjected to.

A new method of preparing cast steel has been lately announced in France by Clouet. His process is the following: Take small pieces of iron and place them in a crucible, with a mixture of carbonat of lime and the earth of Hessian crucibles; six parts of the carbonat of lime, and six of this earth, must be employed for twenty parts of iron. The mixture is to be disposed so, that after fusion the iron may be completely covered by it to prevent the iron from coming into contact with the external air. The mixture is then to be gradually heated, and at last exposed to a heat capable of melting iron. If the fire be well kept up, an hour will generally be sufficient to convert two pounds of iron into excellent and exceedingly-hard steel, capable of being forged; an advantage not possessed by steel in the common manner. The oxyds of iron are equally susceptible of passing to the state of soft iron, steel, and cast iron, according to the quantity of carbon employed. The black oxyd, the state of which seems to be the most unalterable, becomes iron when treated in the crucible with an equal volume of charcoal-dust. By doubling the quantity of the charcoal, steel is formed, and a progressive increase gives it the characters of white and grey cast iron. A fifth part only of cast iron is required to convert iron into steel. The iron and the oxyd do not unite intimately. The black oxyd, mixed with one half less of carbon than is necessary for its reduction, gives a soft iron, but not very tenacious, black, and without a granulated fracture. A sixth part of the oxyd brings back common steel to the state of iron, by treating them together, either in the forge or by cementation.

Magnetism is a characteristic of iron; it appears every where, even in stone, in marble, and in bodies where it exists in very small quantities, and is only a colouring principle. In the grey marble of Campan

pan it attracts the magnetic needle; in the green marble it does not, though that contains more iron; but in this last it is more oxydated.

Iron has a considerable smell, especially when rubbed or heated. It likewise has a very evident styptic taste, which acts strongly on the animal economy. Next after tin, it is the lightest of metallic substances, except the newly-discovered metals, potassium and sodium: a cubical foot of this metal, when forged, weighs 580 pounds. It may be extended into plates by beating; but as it is very hard, and becomes still harder under the hammer, it cannot be made into leaves. Its ductility, when drawn into wire, is much more considerable; very fine wires being made of this substance for musical purposes: this property appears to depend on its tenacity. In fact, iron is the most tenacious of all metals, except gold. An iron wire, of one tenth of an inch in diameter, sustains a weight of 450 pounds without breaking. Another singular property is that of taking fire, or suddenly melting, by the stroke of a flint; a phenomenon to which the poets universally attribute the discovery of fire by the first men. Another property which distinguishes it is, that it is found with manganese in plants and animals, whose fluids it partly colours. It is likewise susceptible of a regular form, or crystallization. If iron-filings be thrown on burning coals, or even through the flame of a taper, it suddenly takes fire, and produces very brilliant sparkles. These are similar to those produced by the stroke of the steel against flint, and, if collected on a white paper, they are found to be melted, and resemble a kind of scoræ. This metal, exposed to the focus of the lens of De Trudaine, suddenly throws out inflamed and burning sparkles. Macquer, who melted steel and iron in this lens, observed, that steel was the most fusible, which arises from its combination with charcoal. Iron melted and suffered to cool slowly, takes a peculiar crystalline

talline form; Mongez described it to be a pyramid of three or four sides.

By means of water, a preparation is made with iron, known by the name of *Martial Ethiops*, or *saffron of Mars*. There are a vast many processes for obtaining Ethiops. The following are selected as most worthy of attention. 1. That of Vauquelin. Take two parts of iron in fine powder, and one part of red oxyd of iron; put the mixture into a covered crucible, and expose it to a strong heat for two hours. In this experiment, the iron takes a portion of oxygen from the red oxyd; and, by the balance which is thus established between the two portions of iron, makes the whole pass into a black homogeneous oxyd. 2. That of M. Save. Take hammerings of iron, and reduce them to powder; triturate this powder on marble with a little water; put the mixture into a crucible, and heat it till it is entirely deprived of moisture; then pour in a few drops of oil, taking care to spread them equally; and a very black oxyd is immediately produced, which is to be left some time longer on the fire, in order to burn all the oil: reduce the clots which may be formed. A third method is, to work a certain quantity of iron-filings into a paste with water; then dry it, and add more water; and repeat the operation till all the paste is reduced to a fine blackpowder. Throw this powder into boiling water; and, having left it to settle, draw off the water, and dry the precipitate. If, instead of iron-filings, iron already oxydated be used, a single operation is sufficient to convert the whole into Ethiops.

Water charged with carbonic acid easily dissolves iron: to form this combination, nothing more need be done than to add iron-filings to the acid, and leave the mixture in liquid digestion for some time; this fluid, when filtered, has a penetrating and rather styptic taste. Bergman, who calls this combination *aerated iron*, affirms that, when exposed to the air, it becomes covered

covered with a pellicle of rainbow colours; that it is decomposed by the pure alkalies; but that these salts when saturated with the acid do not produce the same effect. This solution converts the syrup of violets to green, and affords very brilliant Prussian blue with the calcareous Prussiate; it precipitates the brown oxyd of iron when left exposed to the air, or when heated: this combination is now named *carbonat of iron*.

Iron considerably increases the fusibility of earths, especially the oxyds of iron; for, in its metallic state, it does not unite with them. Common glass owes its colours to the iron which is accidentally mixed with the materials it is composed of.

Gold unites easily with iron, and by this union becomes harder and less malleable. In the proportion of six parts of gold to one of steel, the metallic mixture may be beat out into plates without cracking. Iron is only partially separated by combustion in a glow heat. It has a stronger attraction than gold for the oxygenated muriatic and nitro-muriatic acids, and precipitates gold from these acids in its metallic state. Silver combines readily with iron. A mixture of fourteen parts of silver, and two and a half of iron, is more elastic than silver, attracts the magnet, and is not decomposed in a strong fire. A small portion of iron does not seem to injure the colour or malleability of the silver. Iron precipitates silver from all its solutions in acids: but this happens in the nitric only when the acid is not completely saturated, or when nitrous gas is added. Muriat of silver is decomposed in the dry way by distillation with iron-filings. Iron precipitates mercury in its metallic state from its solution in acids.

The uses of iron are so great and extensive, and besides so well known, that it would be useless to attempt to enumerate them: it is only necessary to observe, that no art can be carried on without it, and that it is

foul

the soul of all the arts. The different modifications it is susceptible of, render it very proper for the multiplicity of purposes to which it is applied. Cast-iron serves to form utensils of various degrees of solidity as may be required. The hardness and tenacity of the several kinds of forged iron are no less applicable to other uses. The same observation is applicable to steel: the fineness of the grain, and excellence of the temper, constitute a great number of species, peculiarly adapted to an almost infinite number of arts. The oxyds of iron serve to give a red or brown colour to porcelain, enamel, pottery, &c. they are likewise used in the preparation of artificial precious stones, and combined with oil for painters. Iron is the basis of an important medicine, which is frequently applied with the greatest success. It is the only metal which is not noxious, and whose effects are not to be feared; it has such an analogy with organic matters, that it seems to form part of them, and often owes its production to the processes of life or vegetation. The effects of iron on the animal economy are numerous; it stimulates the membranes of the viscera, and appears to act more especially on those of the muscles, which it braces; it fortifies the nerves, and gives a remarkable degree of force and vigour to the animal system; it excites many secretions, especially the urinary and menstrual evacuations; it increases the contractions of the heart, and consequently renders the pulse stronger and quicker. Its action is not less effectual on the fluids; it passes quickly through the first passages, and combines with the blood, to which it gives density, consistence, and colour, rendering it more concrete, communicating at the same time such a degree of activity as enables it to pass easily into the smallest vessels, which it stimulates at the same time, and communicates force and life through every part. The capital experiments of Menghini, published in the *Memoirs of the Institution of Boulogne*, have proved,

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that the blood of persons who take martial medicines is highly coloured, and contains a larger quantity of iron than it would naturally contain. Lorry, who exercises the art of medicine with that accuracy of observation which characterizes the true philosopher and physician, observed the urine of a patient to whom he had given iron in a very divided state, became manifestly coloured with nut-gall. This metal is therefore tonic, fortifying, stomachic, diuretic, alterative, incisive, and unites in its action the properties of a great number of other medicines. Like astringents, it increases the motion of the parts, and has the advantage of being more constant and durable in its effects than many other remedies which possess the same virtue, because it combines with the organs themselves, by means of the fluids which serve for their nutrition. It seems, therefore, that in every case wherein the fibres of the viscera of the muscles, or even of the nerves, have only a very feeble action, in languors of the stomach, and sluggishness of the intestines, and in weaknesses produced by these causes; in fine, in all the cases wherein the fluids are not sufficiently consistent, or too much diluted, as in palsies and propensities to the dropsy, &c. iron may be administered with success.

NATIVE IRON, *Ferrum nativum*.

The existence of native iron is not nearly so questionable as of lead and tin; though there is still a considerable difference of opinion on the subject. It is said to have occurred in the form of a vein, mixed with iron-ore, at Eibenstock in Saxony: and also in the vicinity of Grenoble in Dauphiny; but, in the greater number of instances, those specimens which are preserved in cabinets under the name of native iron, have been detached from insulated masses met with on the surface of the earth. These masses are totally unconnected, not only with the neighbouring substances,

substances, but with every mineral hitherto discovered; with the exception at least of certain earthy bodies, found under similar circumstances, which will be spoken of at the close of the present subject.

Mr. Howard (Phil. Transf. 1788) mentions three different masses of native iron: one, met with in Siberia; another, in Senegal; the third, in South America; the last-mentioned weighs fifteen tons. A mass of native iron has also been met with in Croatia.

The Siberian native iron was discovered by Pallas: the weight of it was equal to 1680 Russian pounds. According to his account, the Tartars consider it as a sacred relic that had dropped from heaven. The structure of this substance is cellular; in which it corresponds with other masses of native iron; many of the cells have remarkable smooth and polished surfaces: some of them are filled with transparent particles of a yellowish green colour; and as these particles correspond in dimensions and form with the cells containing them, and are liable to decomposition, it is presumed that the cells now empty were once occupied by similar particles. The internal colour of the native iron of Siberia is like that of cast iron: it is externally covered with a thin ochry incrustation, or rather simply a tarnish, of a yellowish brown colour. It is very malleable; and may be easily cut by the knife.

Specific gravity 6.48, which is much below that of forged iron: but the difference is accounted for by the cellular and porous character of the native substance. It contained iron 98.3, nickel 1.7. The analyses of other varieties of native iron, except in one or two instances, correspond closely with that of the Siberian. And, since they almost universally contain a portion of nickel, they seem more properly to belong to the next species, which we call

METEORIC IRON, *Ferrum meteoricum.*

Amorphous, of a granular texture, outwardly covered with a black scoriaceous crust, internally ashy-grey mixed with minute shining particles. Found at Wold Cottage in Yorkshire, in Scotland, various parts of the continent, at Benares, and in America and Siberia, where they have been deposited by the bursting of meteors: at first, when they fall from the atmosphere, they are said to be hot, and their descent to be accompanied with a loud explosion and hissing noise: they are found of various magnitudes, from a few ounces to several tons in weight.

It is worthy of observation, that a similar alloy of iron and nickel is constantly met with in these compound bodies, which are found in equally insulated situations with the masses of native iron already mentioned: and the tradition and account of the origin of the compound and of the metallic bodies is the same; for it is asserted that both have fallen from the air. However improbable this opinion may appear at the first view; yet, when we consider that these substances differ in their composition from all hitherto known, and at the same time remarkably resemble each other; that, in very different parts of the world they are met with under circumstances, which in themselves might lead to the supposition that they had fallen from a great height on the spot where they now are; and that the tradition and accounts of those who live in the neighbourhood almost invariably corroborate this opinion; and, lastly, that in one or two instances they have appeared for the first time at the moment of the explosion of a meteor; and have then been of a much higher degree of temperature than they have ever since been, or in their present situation can be:—when all these circumstances are considered, it would hardly be a mark of wisdom to disbelieve at least the possibility

possibility of such an origin as that to which they are generally ascribed.

Some have supposed that these masses have been projected from another planet; beyond the sphere of whose attraction they have been carried, by a force which has brought them within the sphere of this. The notion is uncommon, but cannot be called absurd.

Mr. Howard has given an accurate account of these earthy substances in the same paper which contains an account of the native iron of Siberia. He says that they are upon the whole distinguished by the following characters: Their form is irregular. Externally they are covered with a thin incrustation of a deep black colour; the surface of which is rough, like fish-skin, and without the smallest gloss: this incrustation seems to possess the properties of iron in a low state of oxydation. Internally they are of a greyish ash-colour. Their texture is granular, and resembles that of a coarse grit-stone. Small grains of a yellow colour and metallic appearance, not unlike iron pyrites, are irregularly distributed through their substance: these when powdered are black, and are not attracted by the magnet. Particles of perfectly-metallic iron are also found in the substance of these stones; but not in such abundance as the last mentioned particles: they are completely malleable; are attracted by the magnet themselves, and communicate the same property to the stone; of the whole weight of which they constitute about one fiftieth part. The two foregoing substances, together with numerous globular or elliptical bodies which vary in size from that of a small pin's head to a pea, are cemented together by means of a friable earthy substance of a whitish grey colour. These stones have no argillaceous smell when breathed on.

Mr. Howard examined three different varieties of these stones: one of which came from the Siennese territory, in Italy; another, from Yorkshire; and the third,

third, from the neighbourhood of Benares, in India. The foregoing description, though applicable to all in general, is derived from the last; as possessing the most distinct characters.

The first was part of a stone, which, together with eleven others, fell near Sienna in Italy, on the 12th of July 1794. They fell in the midst of a violent thunderstorm, about eighteen hours after an eruption of Vesuvius; which mountain is two hundred and fifty miles distant: upon examination they were found to differ from any stone met with in that neighbourhood. Sir W. Hamilton received a piece, weighing five pounds, which had been detached from one of the largest. The second was part of a stone, weighing fifty-six pounds, which fell near Wold Cottage, in Yorkshire. It fell on the thirteenth of December, 1795, at three o'clock in the afternoon: the day was mild and hazy. The stone, when found, had penetrated through twelve inches of soil or loose earth; and six inches of solid rock: when first extracted it was warm, smoked, and exhaled a strong smell of sulphur. The last was part of a stone which fell with many others, one of which weighed almost three pounds, at about the distance of fourteen miles from Benares. It fell on the nineteenth of December, 1798, at eight o'clock in the afternoon. The sky was perfectly serene for many days before and after the fall.

The specific gravity of the stone from Italy was 3.41

- - - - - Yorkshire 3.50

- - - - - Benares 3.35

A piece of the Yorkshire stone contained, in 150 parts, silica 75, magnesia 37, oxyd of iron 48, oxyd of nickel 2, making an excess of 12 from the absorption of oxygen during the process of analysis. The Benares and Sienna stones gave nearly the same proportion of oxyd of nickel as that of Yorkshire.

Let us repeat, that, with one exception, native iron invariably contains nickel; as do also the metallic particles

ticles of the stones above described. The other constituent parts are the same in both ; and only differ in their proportions. If therefore you suppose the metallic particles of the stones, or the globular earthy particles of the native iron, to be increased in quantity; the latter at the same time losing their transparency: the native iron and stones would approach nearly to the same state : and, from the above data, Mr. Howard conjectures there may be a natural connexion between the two substances; and both that have been deposited originally from meteors.

COMMON IRON ORE, *Ferrum selectum*.

Attracted by the magnet, reducible to grains, black with a black streak, of a very granular texture and common form. Found in most iron mines, and yields a considerable proportion of good iron. There are many varieties.

OCTAHEDRAL IRON ORE, *F. crystallinum*.

Attracted by the magnet, black with a black streak, in the form of crystals. Found in various parts of Britain, Norway, Sweden, Germany, Corfica, &c. generally strongly attached to their matrix: the primitive form of the crystals is regularly eight-sided, or cubical, or in six-sided prisms terminated by three quadrangular faces. Colour greyish-black or grey with more or less of a metallic lustre, and they give a black powder. Specific gravity from 4.200 to 4.939.

MAGNETIC SAND, *F. glareosum*.

Attracted by the magnet, black with a black streak, in the form of sand. Found in Italy at the base of volcanic mountains, in the rivers and on the shores of Great Britain, Siberia, Greenland, Bohemia, Jamaica, and India, and seems to be the fragments of other ores washed down and comminuted by torrents and the waves

waves of the sea. The grains are obtusangled, deep glittering, very hard and magnetic, of a conchoidal fracture, not altered by the blowpipe, melting into a black glass with potash, and into a green glass with microcosmic salt. Specific gravity 4.6.

LAMELLATED IRON ORE, *F. lamello sum.*

Attracted by the magnet, black with a red streak, lamellar. Found in Norway, Russia, Siberia, India, and Mexico; iron-black, solid, shining, with a lamellar texture. Contains a large proportion of iron.

MAGNET, OR LOADSTONE, *F. magnes.*

Magnetic, compact, of a common form. Found in the mines of Denmark, Sweden, Norway, Lapland, Siberia, Bohemia, North America, and Peru, in masses, plates, grains, or eight-sided crystals. Colour generally iron-black, brown, steel-grey, or bluish. It is hard, brittle, with commonly a little lustre, and breaks into indeterminate obtusangled fragments: it often contains above 70 per cent of iron. A mountain in Peru is mentioned, which consists entirely of magnet.

Magnetic iron ore is reduced to a metallic state by fusion with coke or charcoal; and, if the process be carefully conducted, it at once produces iron of the best quality. If too quickly fused, its oxygen is not entirely separated; and the iron when at a red heat is consequently often brittle: in which state it is technically called *red-short iron*. Mr. Kirwan observes with respect to this property, that metallic calces, or oxyds, never thoroughly unite with substances in their fully-metallic state; hence, when iron imperfectly reduced, in which case many of its particles are in an oxydated state, is much dilated, as it is in a red heat, the points of contact are too few, and a division or fracture necessarily takes place. He adds, that sulphur in ever

so small a proportion, or clay, or any other foreign ingredient, produces the same effect.

This may be distinguished from specular iron ore, by the black colour of its powder; the powder of specular iron ore having generally a shade of red mixed with black: also, by the readiness with which it is attracted by the magnet; which seldom has much influence on even the smallest particles of specular iron ore. The octohedral form of the crystals of the former species is also a good distinctive mark, where it is present. It may be distinguished from granular sulphuret of lead by the readiness with which it obeys the magnet.

COLUMNAR IRON ORE, *Ferrum basalticum*.

Magnetic, brownish-red, formed of slender columns adhering to each other, and which are generally incurved. Found in Bohemia, Franconia, &c. generally in large strata, consisting of columns which are easily separable, sometimes jointed, and with their surface rough. It slightly stains the fingers, feels dry, adheres to the tongue, sounds hollow when struck, blackens before the blowpipe, effervesces with borax, and gives it an olive-green and blackish tinge.

MICACEOUS IRON ORE, *Ferrum micaceum*.

Not magnetic, iron-grey, shining, of a lamellar texture. Found in Wales, Scotland, Cornwall, &c. also in Siberia, Lapland, Sweden, Hungary, and other parts of Europe, massive or disseminated, variously grouped, or crystallized in small six-sided tables. Colour bright iron-grey, bluish, or approaching to black. Foliations brittle, straight or incurved, and rarely present a granular concretion: feels somewhat greasy, and does not stain the fingers. Specific gravity from $4\frac{1}{2}$ to 5.

SPECULAR IRON ORE, *Ferrum specular.*

Not magnetic, compact, of a steel-grey colour and lustre, with a red streak, internally specular. Found in the mines of Lancashire, in the isle of Elba, Germany, France, Russia, &c. massive, disseminated, or crystallized. Colour dark-grey or inclining to brown, the surface often tarnished, and exhibiting various iridescent colours: crystals cubic or rhombic, or in flat six or eight sided-tables, or in prisms and pyramids, often cellularly disposed in thin erect angular plates. It gives a dark-red streak, and blackish-red powder; is hard, but not brittle. Specific gravity 5. Contains iron 66.1, oxygen 21.2, water and carbonic acid 10.7, lime 2.

This ore frequently occurs distinctly crystallized; the most beautiful forms of which variety come from the isle of Elba: the interstices of the crystals of the Elba-iron are often occupied by a white earthy substance, and by brownish-red ochre; and their surface is frequently iridescent, or of a greenish-bronze colour. The iridescence of this mineral is peculiarly brilliant. The specular iron ore of Norway and Sweden is often laminated; and the mass is divided by numerous fissures, resembling lines, which cross each other obliquely so as to leave rhomboidal interstices: these lines are parallel to the primitive crystalline form of this variety of iron. Sometimes the laminæ are curved: at others they insensibly graduate into radiating acicular prisms. A variety of the form last mentioned occurs in irregular nodules, imbedded in masses of brownish-red ochry clay, near Totness in Devonshire. When reduced, it afforded nearly seven tenths of metallic iron. A delicately-crystallized form of specular iron occurs in the hematitic iron ore found near Bristol: the form of the crystals is usually lenticular, but so much flattened as to appear merely laminar: they accompany

accompany pyramidal crystals of completely-transparent quartz; and these crystals often appear black in consequence of the colour of the specular iron placed under and seen through them. Specular iron may be distinguished from magnetic iron by the red shade observable in it when pulverized; besides which it is rarely attracted by the magnet: from grey copper, by the red shade of its powder: from granular sulphuret of lead, which it often resembles, by the same mark: from wolfram, by its lighter colour and brighter lustre; and by its inferior specific gravity: from dark-coloured mica, by its metallic brilliancy and greater specific gravity.

RED SCALY IRON ORE, *F. rubricosum*.

Not magnetic, red, lamellar, shining internally, very soft, greasy to the touch and staining the fingers; of a common form. Found in Lancashire, Wales, Sweden, Saxony, Hungary, &c. most commonly incumbent upon other ores and minerals: colour cherry-red, often passing into steel-grey or brown: texture foliated, with the scales generally incurved with distinct fine-grained concretions. When heated it reddens, but before the blowpipe blackens, and gives an olive-green tinge to borax.

This species is met with at Ulverstone, and several other places on the borders of Lancashire. It affords very good iron; and, as the proportion of earthy matter is small, it requires very little limestone for its reduction. Where the proportion of earthy matter in a metallic ore is large, and of an argillaceous nature, as is most commonly the case, limestone is necessary in the reduction of it, in order to vitrify the earthy particles; lime very easily acting upon other earths so as to convert them into glass: and in the reduction of an ore this glass floats on the surface of the reduced metal, and is called a *slag*. Its colour is usually a brown or bluish green, in consequence

consequence of the presence of oxyd of iron; which has the property of communicating a green colour to glass. Red iron ore may be distinguished from compact sulphuret of quicksilver, or cinnabar, in not being volatilized by heat; also in becoming magnetic by the application of the blowpipe.

HEMATITE, *Ferrum hæmatites*.

Not magnetic, fibrous, hardish, opaque, with a red or yellow streak. There are four varieties, black, brown, red, and yellow. They are found in various parts of England and Scotland, particularly in Lancashire, in Russia, Siberia, and other parts of the continent; massive, disseminated, nodular, botryoidal, tabular, cellular, tubular, or stalactitical; hard, compact, fibrous, or radiated, with the fragments usually splintery or wedge-shaped; the fibres are stellate, or sometimes in distinct columns. The surface often variegated, and sometimes marked with shrublike ramifications. Specific gravity from 3.423 to 5.

The word *hematite* is derived apparently from those varieties, which, in consequence of their colour and tubercular form, resemble a mass of coagulated drops of blood: many of these very readily stain with a red colour whatever they come into contact with; and this is an additional reason for the name.

It was mentioned under the species called specular iron ore, that the crystallized variety, met with near Bristol, often accompanied hematitic iron ore: other varieties of specular iron ore also very frequently accompany hematite; and although the two substances, when possessing their appropriate characters most perfectly, are exceedingly different; yet they insensibly graduate into each other. Thus some of the Cumberland specimens of hematite are of so compact a texture externally, that their surface has a smoothness and splendour scarcely surpassed by the
Elba

Elba iron; and sometimes indeed they almost appear to be portions of similar crystals, since they have distinctly crystalline surfaces. On the other hand, in the specimens from Bristol above mentioned, the extreme parts have the perfect appearance, one of hematite, the other of specular iron; and the transition from one state to the other advances so gradually as to be imperceptible to the eye. This natural connexion between the two substances seems easily explicable from the familiarity in their composition, their nearly equal degree of specific gravity, and the red shade of colour constantly observable in pulverized specular iron ore.

Pebbles of native oxyd of iron, in an intermediate state between specular and hematitic ore, occur in some instances; and, on account of their hardness and smoothness, are used as burnishing-stones in the enamelling of gold, &c. hematite itself, when sufficiently compact and hard, is used for the same purpose. Fibrous hematite is sometimes disposed to separate into masses resembling splintery fragments of wood. In some instances the fibres converge in a curved direction.

COMPACT RED IRON ORE, *F. compactum*.

Not magnetic, compact, opaque, with a red or yellow streak. Found in Lancashire, Siberia, Saxony, Bohemia, &c. massive, disseminated, or variously imitative, sometimes forming beds or veins. Colour between brownish-red and steel-grey. Fracture even or uneven, sometimes imperfectly flat or conchoidal. It stains the fingers, blackens before the blowpipe, and gives a yellowish-green tinge to borax. Specific gravity 3½.

SPARRY IRON ORE, OR PEARL SPAR, *F. spatosum*.

Not magnetic, lamellar, effervescing with acids, crackling and blackening before the blowpipe, breaking

ing into rhomboidal fragments. Found in various parts of Great-Britain and Europe, sometimes massive, or disseminated, or in small crystals. Colour when fresh white, but gradually tarnishing to red, brown, yellow, bluish, or variegated: streak grey or whitish: fragments rhomboidal, with often a pearly or fatty lustre: it is soft, and can easily be scraped with a knife; soluble with some effervescence in acids, and decrepitates and becomes blackish and magnetic before the blowpipe. Specific gravity 3.6: contains iron 38, carbonat of lime 38, manganese 24. The iron obtained from this ore is in general of a very good quality, and easily converted into steel: sometimes indeed a part of the reduced metal is in the state of steel upon its first reduction: hence this ore is sometimes called *steel ore*. It is rarely met with in England. In the central parts of Europe it occurs in great abundance, and has been smelted for many centuries.

ARGILLACEOUS IRON ORE, *Ferrum argillaceum*.

Soft, opaque, without lustre, dry. Found in various parts of Great Britain, in Italy, Saxony, Germany, Bohemia, &c. in detached lumps or forming strata, fistular, cellular, or variously imitative: colour reddish or yellowish grey, or various shades of brown or black, with the surface often uneven and buncy: adheres to the tongue, and has a compact, even or uneven, flaty or splintery, fracture: it generally gives a reddish-yellow streak, and has an earthy smell when breathed on. Specific gravity from 2.673 to 3.471: it is composed of oxyd of iron, alumine, lime, and flint, in various proportions. It affords from thirty to forty parts in a hundred of metallic iron: but most commonly not much more than thirty. The iron however obtained from it is of a remarkably good quality.

This is the ore which is worked so extensively in
South

South Wales, in Shropshire, and at Carron in Scotland. Its value is increased by the coal and limestone that usually accompany it: the limestone being necessary for the purpose of vitrifying the argillaceous part; the coal, for the purpose of reducing the oxyd of the iron. The first process reduces the metal to that state in which it is called *crude*, or *cast*, or *pig*, iron: the first of which terms expresses its imperfectly metallic state; the second, that in a state of fusion it has been received into appropriate moulds; and the third, by a whimsical comparison, the form of those moulds; that is, the melted iron being received into a broad longitudinal cavity, from which numerous smaller cavities branch out at right angles, the whole presents the appearance as it were of an animal suckling a number of its young lying on each side of it. The iron in this crude state being imperfectly reduced, and having also imbibed a portion of the coaly matter employed in its reduction, is too brittle and too hard for common purposes. In the subsequent process it is thrown into an horizontal furnace, and kept constantly in contact with the fuel by which the furnace is supported: and, as the heat is sufficient to soften without melting it, it is kneaded constantly by means of long rakes worked by men from the mouth of the furnace, till by degrees the oxygen contained in it is entirely separated; and the iron in that respect is reduced to a completely metallic state. The increasing toughness of the kneaded mass affords the means of estimating the progress of the operation. But as iron at a high temperature very readily imbibes charcoal, on which property indeed depends the fabrication of steel, the kneaded mass of iron is not yet of its ultimate degree of purity; in consequence of its containing a greater or less proportion of charcoal. This may in a great measure be separated by mechanical force, as hammering and rolling: but in being separated it carries with it a
portion

portion of the iron. This compound of the charcoal and iron, which is analogous to the natural mineral called plumbago, is the substance which flies off in the form of brilliant sparks from a piece of iron, of a white or a high red heat, when struck by the hammer on a common anvil; or from those larger masses which have lately undergone the process of reduction, when flattened by the more powerful engine of a foundery.

RED OCHRE, or IRON OCHRE, *F. ochra.*

Not magnetic, without lustre, opaque, friable. Found in every country abounding in iron-ores, sometimes in solution in waters impregnated with iron, sometimes compact or hardish, rarely fibrous in a stellate manner. Colour various shades of red or yellow, passing into brown by exposure to the air: streak red or yellow: it adheres to the tongue, stains strongly, and is principally employed in drawing and writing.

BLUE EARTHY IRON ORE, *F. cærulea.*

Not magnetic, friable, earthy, without lustre; becoming blue by exposure to the air, and brownish in the fire, changing its colours in a solution of soda. Found in many parts of England and Scotland, Siberia, Russia, Sweden, Norway, Poland, Germany, &c. in marshy grounds at various depths, generally in an earthy state and without any regular shape, adhering to the stones and pebbles which surround it: colour generally whitish when first taken from the soil, and becoming gradually of a fine blue by exposure to the air; though, according to Mr. Sowerby, it is sometimes blue when fresh gathered and first broken. It stains strongly, feels harsh to the touch, is moderately heavy, and dissolves readily in acids. When heated on red-hot coals it inflames and leaves a red powder; before the blowpipe

blowpipe it becomes reddish brown, and melts into a black bead, and tinges borax of a dark yellow: in water it preserves its colour, but becomes black in oils. It is by Klaproth considered as a phosphat of iron.

LOWLAND OR BOG IRON ORE, *F. subaquosum*.

Not magnetic, without lustre, opaque, of a dull colour, humid. Found in Great Britain and various parts of Europe, in low swampy situations, stagnant lakes, or brook-waters; sometimes massive, but commonly in detached lumps of various shapes, as placiform, flat and rounded, globular or kidney-form, when it is called *eagle-stone*, granular, or pisiform, generally perforated, fistular, or spongy. Colour brown, with various shades of red, green, yellow, blue or grey: texture earthy, brittle. It consists of oxyd of iron combined with phosphoric acid and alumine.

According to Werner, this species of iron ore is formed in the following manner: "The water which flows into marshy places is impregnated with a vegetable acid, formed from decaying vegetables, which enables it to dissolve the iron in the rocks over which it flows, or over which it stands. This water having reached the lower points of the country, or being poured into hollows, becomes stagnant; by degrees evaporates; and, the dissolved iron being accumulated in quantity by fresh additions of water, there follow successive depositions, which at first are yellowish, earthy, and of little consistence; and this is *morass-ore*: but in course of time they become harder, their colour passes to brown, and thus *swamp-ore* is formed. After the water has completely evaporated, and the swamp is dried up, the swamp-ore becomes much harder, and at length passes into *meadow lowland-ore*, which is already covered with soil and grass.

GREEN EARTHY IRON ORE, *F. viride*.

Of a green colour, shining, dissolving in acids with difficulty, friable. Found at Schneeberg in a matrix of quartz and clay, compact, solid, or like a corroded stone, oftener investing or incumbent, and seldom indurated. Colour various shades of green or yellowish green, with a dull lustre: it stains the fingers, and blackens when strongly heated; with borax it easily melts into a yellowish-brown opaque glass with some black spots: it is supposed to consist of alumine, filix, manganese, and from 10 to 12 per cent. of iron.

MISPICKEL, OR ARSENIAT OF IRON, *F. arsenicale*.

Grey or greenish, not magnetic, emitting arsenical vapours when thrown on red-hot coals. Found in the copper-mines of Cornwall and in Spain, in small pieces, or generally crystallized in cubes: its fracture is granular, and it has no transparency: specific gravity from 3 to 3.4: it contains arsenical acid, oxydes of iron and copper, filix, and water, in various proportions.

SULPHURET OF IRON, OR IRON PYRITES, *Ferrum sulphuratum*.

Opaque, emitting sulphurous flames and vapours when thrown on hot coals. This combination of iron and sulphur has been already described under the genus Sulphur, p. 531. The word *pyrites* is derived from the use to which it was formerly applied, of obtaining sparks by percussion, as from the common flint and steel. Pliny mentions this application of pyrites very particularly. It is called *iron pyrites* to distinguish it from copper pyrites, which it often closely resembles.

The substance known by the name of *piedra de los Incas* is a cubic form of iron pyrites; which from
its

its size, and the splendour of its surface, was used by the monarchs of Peru as a mirror. The surfaces of cubic crystals of iron pyrites are in general striated in such a manner, that the lines of any one are at right angles to those of all the adjoining.

Besides its distinctly crystalline forms, iron pyrites occurs in serrated plates resembling a cock's comb: in capillary filaments: in radiating fibrous masses: in all kinds of stalactitic shapes: in the form of small mushrooms: in rounded nodules, which from the roughness of their surface have been compared to mulberries; this roughness being occasioned by the projecting points of small crystals clustered together: sometimes in masses in which the distribution of the several parts presents an appearance similar to some varieties of agate; particularly that called *fortification agate*: and, lastly, in grains loosely aggregated in marl; and in the form of an incrustation on coal and fossil wood.

Sulphuret of iron is disposed to undergo two very different changes by exposure to the air: for either the sulphur is dissipated; or, by absorption of oxygen, it is converted into sulphuric acid. In the first instance, the pyrites gradually loses its metallic splendour, and is ultimately reduced to the state of a brown oxyd of iron: from its colour the decomposed sulphuret is distinguished by the epithet *hepatic*. This variety frequently contains gold, and is consequently called "*auriferous pyrites*;" but the gold is not chemically combined with the other constituent parts of the pyrites; it is simply mixed with them; and therefore, as the decomposition proceeds, its particles become more apparent. In the second instance, the acid produced by oxygenation of the sulphur combines with the iron, and forms the metallic salt called *sulphat of iron*, or green vitriol. Radiated and stalactitically-formed masses of pyrites are particular subject to this spontaneous alteration.

There is no depth to which mining has been carried where iron pyrites is not found: one of its most common appearances perhaps is under the form of cubic crystals imbedded in varieties of slate. The substance of fossil shells, especially of the variety called *cornu ammonis*, is frequently pyritical.

The variety called *magnetic pyrites* does not occur crystallized: its magnetic property depends on the small proportion of sulphur contained in it.

Iron pyrites is never worked as an ore of iron: it is principally valuable on account of the sulphur contained in it; which is either separated by means of heat; or, in consequence of artificial processes, is made to undergo that alteration which gives rise to the production of green vitriol. Iron pyrites may be distinguished from copper pyrites by its greater hardness; from native gold, by its want of malleability.

BITUMINOUS IRON ORE, *Ferrum phlogisticum*.

Opake, of a dusky colour, inflammable. Found in Hungary and Sweden, in external appearance resembling a piece of coal; texture friable, or rather firm, or fixed: it quickly kindles, and burns with a light flame, losing something of its weight: consists of bitumen with about 30 per cent. of iron.

STANNUM, TIN.

GENERIC characters, Silvery-white, tarnishing in the air; softish, very malleable and ductile, not sonorous, flexible, and crackling when bent; specific gravity 7.291: easily melting, and the surface soon becoming covered with a grey powder, which gradually changes to yellow if the heat be continued; in a very violent heat running into a fine white glass: soluble in acids, but not totally in the nitric; giving the solution a bitter taste, and forming a purple precipitate when mixed with a solution of gold.

Tin is of a whiter and more brilliant colour than
• lead,

lead; but not quite so white as silver; by the alchemists it had the name of Jupiter. It is sufficiently soft to be scratched with the nail. In water it loses about one-seventh of its weight. It has evidently a smell, which becomes much stronger by heating or rubbing. It has likewise a peculiarly disagreeable taste, so strong, that some physicians have supposed it to have a sensible action on the animal economy, and consequently have recommended it in several disorders. Its extreme softness renders it scarcely at all sonorous. Tin is the second among metals in the order of ductility; it is reducible beneath the hammer into laminæ thinner than leaves of paper, which are of great use in many arts. Its toughness is such, that a wire of tin, of the tenth of an inch in diameter, supports a weight of forty-nine pounds and a half without breaking. The abbé Mongez did not succeed in his attempts to crystallize tin; but De la Chenoye succeeded, by fusing the tin for a number of successive times, by which means he obtained a rhomboidal assemblage of prisms or needles, united longitudinally to each other.

The specific gravity of tin, according to Kirwan, is 7.67 times that of water; according to Briffon, 7.29. It is not more elastic than lead. Its fusibility has not been well determined; some equivocal experiments have been made, which fixed it at 168° of Reaumur; in which case its fusibility must be greater than that of lead, which melts only at 258° of the same scale, employing the same means. This fluidity cannot be determined by Wedgewood's pyrometer, because that begins only at 460° of Reaumur's thermometer. It melts, however, at a heat of about 420 degrees, long before a red-heat is produced, and remains fixed as long as the fire is not raised; but a considerable heat volatilizes it. If heated with access of air, its surface becomes covered with a dull greyish pellicle, and assumes a shrivelled appearance.

appearance. When this is taken away, the tin is seen underneath with all its metallic brilliancy. A new pellicle soon becomes collected, and in this manner most of the tin may be reduced into pellicles, which are nothing else but a metallic oxyd, or combination of the metal with the oxygen of the atmosphere. Then take the vessel off the fire; let it cool; pulverize the oxyd in an iron mortar; pass it through a sieve, to separate the uncalcined portions of the tin. Take the oxyd thus prepared, and calcine it afresh, in an earthen capsule, in a cupelling or Macquer's furnace, for six or seven hours, taking care to stir it from time to time with an iron hook; the oxyd becomes white, and is more oxydated: in this state it is called *putty of tin*; and is used for polishing looking-glasses, steel, and other hard bodies.

The other uses of tin are very numerous. It is applied to many purposes in the arts, in forming many vessels, organ-pipes, decorations, &c. Bell-metal, and bronze for statues, are compounds of this metal with copper. The pewterers mix tin with bismuth, antimony, lead, and copper, to make utensils of all sorts, which are very subject to change by exposure to air. Tin is melted with oxyd of lead and sand, to make enamel, as well as to glaze pottery, &c. The crystallized muriat of tin is useful in the art of calico-printing. Its solution in aqua regia, or nitro-muriatic acid, heightens the tincture of cochineal, of gum lac, &c. so as to convert it into the most lively fire-colour. The dyers make use of this solution, which they call *composition*, to make scarlet.

Many physicians, who have directed their attention to metallic substances considered as medicines, have acknowledged the innocence of tin, and have even advised its filings to be taken in substance in disorders of the liver, of the matrix, and for worms. Schulz, in his dissertation on the use of metallic vessels in the preparation of food and medicines, recommends
pure

pure tin as very wholesome. La Poterie prescribes oxyd of tin as one of the component parts of a preparation called *antihætic*, which consists of oxyds of antimony and tin formed by detonation with nitre. Some people are in the habit of infusing sweet wine for four hours in the cold, in a tin vessel, and giving a glass of this liquor to their children who are troubled with worms. It acts as a violent purgative.

NATIVE TIN, *Stannum nativum*.

Specific character, white, unalloyed, with metallic lustre. The existence of native tin is questionable. A mineral substance was met with some years since, in Cornwall, having some of the external characters of molybdena; it was, in the mass, very brittle; but particles were detached from it, which were malleable, had a metallic splendour, and in every respect resembled tin. Since that time a substance has been met with in France, which at first was supposed to be native tin; but, according to M. Haüy, the situation in which it occurred being accurately examined, there appeared strong reasons for believing that it was an artificial product; though no probable conjecture could be formed as to the means by which it had been conveyed to the spot where it was found.

SULPHURET OF TIN, OR TIN PYRITES, *Stannum pyriticosum*.

It is so called from its analogy, in composition, to sulphuret of iron, or iron pyrites. Specific character, yellowish, steel-grey, with metallic lustre, of a radiated texture, emitting sulphurous vapours when burnt, and leaving a white oxyd. This has been found only at St. Agnes in Cornwall, where there is a vein nine feet wide, and twenty yards below the surface. It is soft, and very brittle. Specific gravity 4.35: contains tin 34, copper 36, sulphur 25, iron 3, earth 2.

NATIVE

NATIVE TIN SPAR, *St. mineralisatum.*

Shining, opaque, milk-white, with a yellowish-white streak. Found near Gieren in Silesia, and in Cornwall, of a common form, or in pyramids or octohedrons: texture frequently fibrous or lamellar: when fused with borax it produces a milk-white glass. Specific gravity 6.

WOOD TIN, OR STREAM TIN, *St. ligneum.*

Pale wood-colour, marked with alternate paler striæ; fibrous in a stellate manner; striking fire with steel; separating into layers, or breaking into wedge-form fragments. It is called *wood-tin* from its colour; and *stream-tin* because it is found (in very small quantities) in the stream-works near St. Columb, and St. Denis, Cornwall, in fragments which are rarely equal in size to a large hazel-nut. The form of these is often wedge-shaped, or irregularly conical; and they are indistinctly marked with striæ, radiating from the apex towards the base; the surface of the base is frequently convex; so that the fragment appears to be, if the term is admissible, the sector of a sphere. The fragments are divided into numerous bands of different dimensions and shades of colour, principally however of a light brown, which cross these striæ at right angles. On the convex surface of some specimens of wood-tin small cavities are observable; which appear to have been formed by the impression of pyramidal crystals of quartz: in other instances these cavities are of a spherical form; and their dimensions are just sufficient to make them capable of containing common shot: hence specimens of this kind are called *shot tin*. Wood-tin often resembles some of the varieties of brown hematitic iron ore.

The specific gravity of stream-tin is very remarkable; for it nearly equals that of the metal itself: whereas the specific gravity of other native oxyds is in
general

general greatly inferior to that of the metals from whence they are derived. Thus, the specific gravity of

Iron	is 7.78;	of the native oxyd	5
Copper	8.66	- - -	3.95
Zink	7.19	- - -	3.52
Bismuth	9.02	- - -	4.50
Tin	7.29	- - -	very nearly 7

The situation in which stream-tin is met with, and it is always found to occupy the lowest part of the works, is evidently the effect of the great specific gravity of the ore; and all the operations of the miner connected with the separation of the ore from the matrix, or from the substances accompanying it, have a reference to this character. With this view, when the ore is disseminated through granite or any other rock, these substances are broken into fragments of a convenient size, and submitted to the operation of stamping; a mechanical process which reduces the mass to a minute state of division: and by means of water, the course of which is directed over the pounded ore, the earthy particles are easily separated from the metallic oxyd; the water washing away the former, and conveying them to a distance, while the latter subsides almost immediately on the spot.

NATIVE OXYD. of TIN, or COMMON TIN-STONE;
St. amorphum.

Compact, opaque, of a common form, colour dusky, with a light grey streak. Found in Cornwall, Devonshire, the Scilly Islands, India, Bohemia, Saxony, Silesia, &c. in masses or rounded pieces: colour dark or blackish-brown, with various shades of yellowish or alby-grey or brownish-red: it is very hard, decrepitates before the blowpipe, and on charcoal is partly reduced: it tinges borax white: specific gravity 6.9: contains tin 77.5, oxygen 21.5, iron 25, flux 75.

The tin-ore of Cornwall is obtained either by mining in the common manner, or by a process called *streaming*. In the first instance, the metallic vein, which is there called a *lode*, is traced by *adits* or *levels*, which are apertures driven horizontally into the rock containing the lode; or by *shafts*, which are similar apertures vertically situated. In the second instance, the ore is found already separated from the native lode: and, judging from its appearance and from local circumstances, has been conveyed to its present situation by rivers, or torrents of water, long ago dried up. The stream-works of Cornwall are generally situated in the low ground that lies between the adjoining acclivities of opposite hills; and the lowest point of these works is the angle made by the meeting of these adjoining and opposite acclivities: their surface is a plane, situated at different heights or distances from this angle, and bounded by the sides of the hills between which it is extended. The measure of this distance differs according to the nature of the spot: in some instances it amounts to many yards; in some, only to a few feet.

The tin-ore is found always in the lowest part of the works; sometimes in the form of sand, which is usually of a dark brown or black colour; sometimes in the form of pebbles, the size of which, gradually increasing from the smallest particles, is occasionally equal to a large orange. The space from the surface of the works to the point where the tin-ore begins to appear, is occupied by common sand, and loose earth or clay; deposited without any regularity, and often containing moss, and branches of trees, and bones of men and other animals. The common miner, in reasoning from these appearances, is forcibly led to the conclusion, that at some former period a violent rush of water has detached masses of tin-ore from the native lode; and washing them away, together with whatever opposed its progress, has

has deposited these substances in the situations where they are now found: and the extraordinary weight of the ore readily accounts for its being constantly found in the lowest relative situation.

Native oxyd of tin is met with more abundantly in Cornwall than any other part of the world. It occurs there in distinct crystals, and in specks and grains disseminated through granite and other rocks: it is frequently accompanied with earthy chlorite and wolfram. It is not found in many other parts of the world: the principal foreign mines are in Bohemia and Saxony; in Galicia; in the peninsula of Malacca, and some of the neighbouring islands. It only occurs in primitive rocks; and, as its veins are always divided by and never divide other veins, it is concluded that of all metallic substances its formation is the most ancient. From this ore all the tin of commerce is obtained.

The preceding species may be considered as a variety of this; and there are two others, the *spatofum* and *crystallinum*, which in the Linnæum system are marked as distinct species.

PLUMBUM, LEAD.

GENERIC characters, Bluish-white, gradually blackening in the air; soft, very malleable, a little ductile and tenacious, not sonorous, staining the fingers of a bluish colour; specific gravity 11.352; easily melting, exhibiting iridescent colours on the surface during liquefaction, and becoming first a white, then a grey, then a yellow, and lastly a red, oxyd, all of which are easily convertible into glass: soluble in all acids, and giving the solution a sweetish taste, precipitating a yellow powder if dissolved in nitric acid and potash be added to the solution.

Lead has little hardness, and still less elasticity; it is the sweetest of metals, having a peculiar smell perceptible on rubbing, which arises from a beginning

of oxydation; the same may be said of its taste. The softness of lead occasions it to be so little sonorous. To this metal the alchemists gave the name of Saturn. Its cohesion is manifest by the adhesion of its parts recently divided, as soon as brought into contact: it is indeed the only metal which can be brought perfectly in contact: if a leaden bullet be cut in two, and the parts immediately put close together, they will adhere very strongly. It easily extends under the hammer, and may be reduced into plates or leaves thinner than paper. To obtain it in grains, it must be melted, and then triturated in an iron mortar.

Lead, exposed to heat, melts long before it becomes ignited. The heat necessary to hold it in fusion is so inconsiderable, that the hand may be plunged in it when melted without pain; and in this state it does not burn vegetable substances. It is said to melt at 540° of Fahrenheit. If it be suffered to cool very slowly after being melted, and the melted portion be poured off from that which is become solid, it is found to be crystallized in quadrangular pyramids. When melted with the contact of air, it soon becomes covered with a grey and dull pellicle; this pellicle is carefully taken off, and reduced by agitation into an oxyd of a greenish grey, verging towards yellow. When separated by the sieve from the grains of lead with which it is mixed, and afterwards exposed to a more violent red heat, it becomes of a deep yellow, and in this state is named *massicot*. This last, slowly heated by a gentle fire, assumes a beautiful red colour, and is known by the name of *minium*. If massicot be strongly heated, so as to produce a semi-vitrification, its parts agglutinate in little thin scales, which preserve their red colour, but not so bright; this oxyd takes the name of *litharge of gold*, and *litharge of silver* when the colour is paler. This composition is never made on purpose: that which is found in the shops is either procured

cured from the purifying of gold and silver in the large way, or from the works for converting lead into litharge. If red oxyd, or litharge, be exposed to heat in a crucible, it will melt, but not so easily as lead, and is converted into glass; which glass is so fusible, that it penetrates the crucible, and escapes. To avoid this inconvenience, add one part of sand to three parts of the oxyd; put the mixture into a good crucible, place it on the muffle of a furnace, and keep it to a white heat for two or three hours, or till it melts: a fine amber-coloured glass will be produced.

Lead is not altered by pure water, because the principles of the water are not separated by that metal; yet the internal parts of lead pipes which conduct water are covered with a whitish crust, or a kind of *ceruse*, which doubtless is produced by the action of the different substances contained in the water on this metallic substance. Mr. Luzuriaga has observed, that by agitating granulated lead in a small quantity of water, with the contact of air, the metal becomes quickly oxydated.

Lead is used in a great number of works. It forms a part of many alloys, and is made into pipes for the conveyance of water. Its oxyds are employed in glass-making, and in the preparation of enamels. It is used to imitate the colour of yellow precious stones, and to give fusibility to the glaze of earthen ware. Utensils and vessels for economical purposes are made with this metal, but not without danger in their use. Fountains, or vessels of lead, in which water is suffered to remain a long time, often communicate a noxious quality to it. Its vapour is dangerous to the workmen who melt it, and its taste is still more dangerous to such as file and scrape it. This metal, lodged in certain parts of the stomach and intestines, produces violent colics, often accompanied with vomiting a very brown bile, and characterized

characterized by the flatness of the belly, and sinking of the navel. It has been observed, that, in such cases, antimonial emetics and purges have been attended with great success. Navier advises the different alkaline sulphurets in cases of poisoning by the preparations of lead, as well as in such as are produced by arsenic and corrosive mercurial muriat. At all events, when these facts are duly considered, we ought to avoid the internal use of preparations of lead, and only apply it as an external medicine; and even in this last it ought not to be administered but with all that care and caution which are required in the use of a strong repellent.

NATIVE LEAD, *Plumbum nativum*.

The existence of native lead has not yet been satisfactorily ascertained; and its ores are so easily reduced, and have been so commonly worked in all ages, that great caution would be requisite in examining local circumstances, in order to determine whether a specimen, supposed to be native, were really so; or only a portion of an ore that had been smelted at some former period. Particles of metallic lead have been found in a porous lava of the island of Madeira; but the peculiarity of their situation may serve to explain their presence. Some affirm that native lead occurs in Monmouthshire, Poland, and Silesia.

EARTHY LEAD ORE, or OCHRE, *Pl. ochraceum*.

Pulverulent, without lustre, totally soluble in nitric acid with effervescence, easily reducible to a metallic state on charcoal. Found in the various lead-mines of Great-Britain, Saxony, Germany, &c. in a loose earthy state, and generally seated on galena: colour white, grey, red, or yellow: it becomes red when exposed to a sufficient heat, and contains a considerable portion of carbonic acid gas: it yields from 60 to 80 per cent. of lead.

GLASS

GLASS OF LEAD, *Pl. vitreum*.

Semitransparent, brittle, of a glassy texture and lustre, and common form. Found in Somersetshire, and the Lead-hills in Scotland, in France, Saxony, Siberia, Hungary, &c. Colour white, grey, or yellowish-green: texture conchoidal or splintery: it does not effervesce with nitric acid.

WHITE LEAD ORE, OR CARBONAT OF LEAD,
Pl. spatosum.

Shining externally and internally, soft, white, decrepitating in the fire, effervescing with acids, generally in the form of crystals. Found in various parts of Great Britain and Ireland, in Burgundy, Austria, Saxony, Hungary, &c. rarely in a globular or cellular form, but most commonly crystallized in rectangular eight-sided prisms with obtuse pyramids variously truncated, or in tables of various forms. Colour silvery or pale white, with sometimes a silky lustre, or tinged with brown, greenish, or yellowish: texture lamellar or conchoidal, of the crystals often fibrous. It is soft enough to be cut with a knife, and is soluble in fat oils: when heated it decrepitates, then turns yellow and afterwards red: before the blowpipe it is quickly reduced, and blackens with sulphurated volatile alkali. Contains oxyd of lead 82, carbonic acid 16.

Many natural crystals of this substance are of a black colour, owing perhaps to a change similar to that which takes place in consequence of the action of alkaline sulphurets: the colour in these instances is only superficial. It has the double refractory power to a high degree; and the double image of an object viewed through it is accompanied with an iridescent appearance, owing to the dispersion of the rays of light. This effect is often observable in the refraction of light by flint-glass; and M. Haüy thinks that flint-glass derives

derives the property of thus dispersing the rays of light from the oxyd of lead, which is one of its constituent parts. This form of lead occurs more commonly than any other, except the sulphuret; but rarely in sufficient quantity to be worked on a large scale. It generally accompanies galena or sulphuret of lead, and ores of zink.

MURIO-CARBONAT of LEAD, *Pl. hyalinum.*

Transparent, effervescing with nitric acid, soft, decrepitating on red-hot coals, of a glassy lustre, in the form of crystals. Found in the mines of Derbyshire and the Harz, in crystals, the primitive form of which is a cube, often lengthened, with the edges generally truncate and replaced by small planes. Colour from a clear transparent white to a pale straw yellow, with a lustre much exceeding that of the last: texture glassy, resembling that of precious stones. It is soft enough to be scratched by carbonat of lead. Contains oxyd of lead 85, muriatic acid 8, carbonic acid 6.

YELLOW LEAD ORE, or MOLYBDAT of LEAD, *Pl. flavum.*

Yellow, in the form of crystals; soft, decrepitating before the blowpipe; soluble in muriatic and sulphuric acids, and giving a blue colour to hot sulphuric acid. Found at the Lead-hill in Scotland, in Carinthia, Britany, Burgundy, the Harz, Austria, &c. seldom massive, disseminated, or lamellar, but most commonly crystallized in small cubic or rhombic or eight-sided plates, rarely in six-sided prisms. Colour various shades of yellow with a waxy lustre, and generally somewhat transparent, with a white streak: fracture conchoidal. Before the blowpipe it decrepitates and melts into a yellowish and blackish-grey mass, producing globules of lead. Contains oxyd of lead 64.42, molybdic acid 34.25.

GREEN

GREEN LEAD ORE, OR PHOSPHAT OF LEAD,
Pl. virens.

Greenish, ponderous, breaking into indeterminate fragments and reducible to a yellow powder, nearly soluble in hot nitric acid without effervescence; melting before the blowpipe, and crystallizing on cooling. Found in the lead-mines of Great Britain, New Spain, Siberia, Bohemia, Germany, Carinthia, &c. massive, disseminated, or crystallized in six-sided columns variously modified: colour various shades of green; with often a mixture of yellowish, greyish, or reddish brown, shining, semi-transparent, with a greenish-white streak and yellowish powder: before the blowpipe it melts easily, and crystallizes on cooling: in muriatic acid it is soluble, and becomes decomposed: texture foliated, fracture inclining to conchoidal: specific gravity from 6.27 to 6.56. A specimen from Wanlock-head contained oxyd of lead 80, phosphoric acid 18, muriatic acid 1.62.

ARSENICO-PHOSPHAT OF LEAD, *Pl. alvernium.*

Greenish-yellow, without lustre, bubbling and emitting arsenical fumes before the blowpipe, and crystallizing on cooling. Found at Auvergne in France. Specific gravity 6.846. Contains arseniat of lead 65, phosphat of lead 27, phosphat of iron 5, water 3.

ARSENIAT OF LEAD, *Pl. arsenicatum.*

Without lustre, melting before the blowpipe but not crystallizing on cooling, emitting arsenical fumes when heated to whiteness, and leaving a bead of lead. Found in the mines of Burgundy and Andalusia, in quartz or feldspar, and in small masses: colour pale green or yellowish-green, with a waxy lustre: when thrown on hot coals, it soon becomes white.

VITRIOLATED LEAD, or SULPHAT of LEAD,
Pl. vitriolatum.

Whitish, without lustre, quite fixed, easily melting before the blowpipe without decrepitation or effervescence; not effervescing with acids. Found in the lead-mines of Strontian in Scotland, in Anglesea, and in Andalusia, sometimes variously modified, but generally in very minute crystals, and mostly above the beds of galena, from the decomposition of which it seems to originate. It is partly soluble in water, and is soon reduced before the blowpipe: contains oxyd of lead 71, sulphuric acid 24·8, water 2, oxyd of iron 1.

Sulphat of lead is distinguished from carbonat of lead by its insolubility in nitric acid: from molybdat of lead in being more easily reduced by the blowpipe.

GALENA, or SULPHURET of LEAD, *Pl. galena.*

Of the colour and lustre of lead; ponderous, soft, presenting granular concretions, breaking into cubical fragments, melting with sulphurous flame and vapours, and when the lead is reduced to a glassy oxyd leaving a bead of silver.

Sulphuret of lead is met with in very great abundance in all parts of Europe; and in no place perhaps more abundantly than in England, notwithstanding the great length of time during which the mines have been worked: and they appear to have been worked antecedently to the arrival of the Romans. Pliny, in speaking of the ores of lead, says, "*Nigrum plumbum in Hispania totasque per Gallias laboriose eruitur: sed in Britanniae summo terrae corio adeo large, ut lex ultro dicatur, ne plus certo modo fiat.*" The epithet *nigrum* is used in order to distinguish the metal in question from tin, which at that time was very commonly called *plumbum album*.

A great proportion of the lead of commerce is obtained

tained from this ore; which is first roasted, in order to dissipate the sulphur, and then mixed with the necessary quantity of coke or charcoal, and reduced in a common furnace. The lead, which remains after the operation of roasting, is in an oxydated state: the coke or charcoal, with which it is mixed in the furnace, decomposes the metallic oxyd; and, combining with its oxygen, flies off in the form of carbonic acid gas, while the lead is reduced to a metallic state, and sinks to the bottom of the furnace. The melted lead, after it has been withdrawn from the furnace and received into the bason placed beneath, presents a singular appearance in consequence of exposure to the air: for its surface is instantly covered with a thin iridescent pellicle, owing no doubt to the incipient state of oxydation produced by the union of the oxygen of the atmosphere with the metal. The appearance is not unlike that superficial iridescence which is often observable on natural specimens of sulphuret of lead; and which, perhaps, depends on a similar cause; the sulphur having been previously dissipated at the surface of the ore.

Crystals of sulphuret of lead are generally very distinct: and are often found completely insulated. M. Haüy says, that this is particularly the case with those crystals which have the mixed form of the cube and octohedron; and he adds, that in some countries crystals of this kind, previously rounded by attrition, are used as bullets. The accidental fracture of most varieties of sulphuret of lead shows very distinctly a crystalline cubic structure; and the substance readily separates into fragments which approach more or less to a cubic form. In some instances there is a broad striated appearance, which is owing to the presence of antimony; that metal being disposed to crystallize in acicular prisms. Other varieties are of a completely granular texture: to these the epithet *steel-grained* is applied; and it is often very difficult

to distinguish them by the eye from granular grey iron ore.

Almost every variety of sulphuret of lead contains a greater or less proportion of silver; and the granular varieties are supposed to contain the most. The silver, after the reduction of the lead, may be separated by the process of cupellation: but in the greater number of instances the proportion of silver is not sufficient to repay the trouble and expence of extracting it: and hence the lead of commerce almost always contains some portion of silver. A piece of common sheet-lead, of a circular form and about the diameter of a sixpence, the weight of which is about a hundred grains, will usually afford by the process of cupellation a globule of silver barely visible to the naked eye. Where the proportion of silver is sufficient to repay the expence of extraction, the process of cupellation is so contrived that the oxydated lead does not sink into the cuppell, but is separated in the form of a semi-vitrified mass called *litharge*.

The minerals that usually accompany sulphuret of lead are, sulphat of barytes, carbonat and fluat of lime, and quartz, among earthy substances; copper pyrites, sparry iron-ore, and sulphuret of zink, among metallic substances: the last-mentioned substance scarcely ever fails to accompany it. This ore usually occurs in veins, and detached masses, imbedded in solid strata; sometimes, though rarely, in rounded nodules imbedded in marl or clay. Brogniart mentions an instance of this kind in Silesia: and a similar instance occurs in that mine, near Castleton, where the blue fluor spar of Derbyshire is quarried.

There is a peculiar form of sulphuret of lead called *lickensides*; a term expressive of the smoothness of its surface. It is a thin incrustation, which appears to have been deposited on the opposite surfaces of natural crevices; thus forming a narrow vein.

vein. The sides of these crevices are barely removed from each other, yet are not actually in contact. In some instances this vein penetrates to a considerable extent: and its presence is made known to the miner by a crackling noise, which is produced by the blow of a hammer or sometimes even the slightest scratch of a pick-axe, against the rock in which he is working: and the noise is usually followed by an explosion of the rock, in the direction and neighbourhood of the vein. The cause of this singular effect is not at all understood.

Sulphuret of lead very closely resembles some varieties of sulphuret of zink; but the metallic lustre of the latter is destroyed by scratching the surface of the ore with a knife, which is not the case with the sulphuret of lead: if both are breathed upon, the ore of lead recovers its brilliancy in a moment; the ore of zink very gradually. Sulphuret of lead is distinguished from plumbago by its greater specific gravity; and by the comparatively faint trace which it leaves on paper: the same marks will serve to distinguish it from molybdena; which is, besides, of a soft foliated texture like talc, and has a considerable degree of flexibility.

The Pl. compactum, or blue lead ore of Thomson, is a variety of this: colour between indigo-blue and lead-grey.—There are two other species of galena: the Pl. plumbago, or compact galena, containing only sulphur and lead, without any mixture of silver; and the Pl. ferriferum, which contains lead, sulphur, silver, and iron.

ANTIMONIAL LEAD ORE, *Pl. stibiatum*.

Of the colour and lustre of lead, fibrous, breaking into crustose fragments. Found in the mines of Siberia, Sweden, Hungary, and Spain, of a compact and striated texture, with the pieces into which it breaks either straight or incurved, and the fibres parallel

parallel or fascicled: when heated, it emits sulphurous flame and vapours: besides lead and sulphur, it contains antimony and silver.

CORNISH LEAD ORE, *Pl. Cornubicum*.

Combined with antimony, a smaller proportion of copper and sulphur, and a very small quantity of iron, with metallic lustre. Found in the mines of Cornwall; and contains oxyd of lead about 50, antimony 21, copper 14, sulphur 7, iron 2.

NICCOLUM, NICKEL.

GENERIC characters, Reddish-white, hard, malleable, attracted by the magnet, and itself convertible into the magnet; specific gravity 9; fusing with great difficulty, but assuming a green colour when heated, and acquiring a purple tinge if the heat be continued; melting with borax into a glass of a hyacinth colour: soluble in all acids, giving the solution a green colour; and in ammonia, to which it gives a bluish-green colour.

It appears that nickel had been used by the Chinese before the European discovery of this metal, since an alloy is known in that country under the name of *paksoud*, which contains nickel. Engestrom discovered that it was a mixture of copper, zink, and nickel; and that the proportions of the last were various, according to the use for which it was intended; they make false jewels of it. Hyerne is the first who wrote of nickel under the name of *kupfer-nickel*, or false copper, in 1694. Hencker regarded it as a species of cobalt, or arsenic mixed with copper. Cramer considered it also as a copper ore. It was not till 1751 that Cronstedt extracted a new metal from this supposed mixture. The discovery of this metal, then, is due to Cronstedt. Several mineralogists have denied its existence, regarding it as a mixture of several metallic substances; but Bergman
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and other chemists have proved, that this substance, so difficult to obtain pure, possesses all the properties of a metal.

NICKEL OCHRE, *N. ochraceum*.

Green, without lustre, of a common form. Found in Saxony, Bohemia, and Silesia, on the surface of other ores of nickel, in the form of powder or indurated: colour apple-green, rarely grass-green, dark-green, or bluish-green: has an earthy appearance, and is very friable: gives an earthy smell when breathed on, and slightly stains the fingers: does not melt before the blowpipe, but gives a reddish or yellowish tinge to borax. It appears to originate from the decomposition of native nickel ore.

ARSENIAT OF NICKEL, *N. metallinum*.

With metallic lustre, entirely soluble in nitric acid, emitting arsenical vapours before the blowpipe. Found in the mines of Bohemia, Saxony, and the Harz, in irregular masses, and often mixed with sulphat of barytes: colour pale grey, with often a mixture of pale green: fracture compact, partly earthy partly splintery, with a white streak: gives an earthy smell when breathed on, and adheres slightly to the tongue: it contains some cobalt and alumine, and often sulphat of barytes, besides the arsenical acid.

NATIVE NICKEL, OR KUPFER-NICKEL, *N. sulphuratum*.

With metallic lustre, not quite soluble in nitric acid, emitting arsenical vapours and sulphurous flame and vapours before the blowpipe. Found at Triego in Cornwall; in Siberia, Sweden, Saxony, Hungary, Bohemia, &c. massive or disseminated, never crystallized, in a matrix of calcareous or heavy spar, and often coated with nickel-ochre. Colour coppery-red with variations of reddish white or grey. Texture compact,

compact, conchoidal, foliated or striated, with often curved lamellar concentric concretions. Before the blowpipe it exhales an arsenical smell, and melts into a bead which gradually darkens by exposure to the air: specific gravity 6.6: it frequently contains bismuth, cobalt, and iron; but always a portion of pyrites.

ZINCUM, ZINK.

GENERIC characters, Brilliant white with a shade of blue; hardish, a little malleable, but not ductile, slightly sonorous, of a fibrous or scaly texture; specific gravity 7.12: burning with a brilliant white flame when heated to a strong degree, and emitting light white flakes; when fused with copper, giving it a brassy-yellow colour: easily soluble in acids, imparting no colour to the solution, but depriving it of its acrimony.

Native zink is very rare; naturalists even doubt whether it exists at all. The ores of zink are not worked for the purpose of gaining this metal. It is observed, during the smelting of lead-ores mixed with blende, that the zink is sublimed in the chimneys of the furnaces, in the form of an oxyd, and produces greyish incrustations, named *tuttia*, or *cadmia fornacum*. Another portion is obtained in the metallic form, by cooling the anterior part of the furnace. The zink, being driven up in the vaporous form by the action of the fire, is condensed in this place, and falls in small grains into powder of charcoal, which covers a stone placed below. This metal is preserved from oxydation by the powder of charcoal, and is afterwards melted in a crucible, and run into moulds. Such is the process by which the greatest part of the zink found in commerce is obtained at Rammelsburg, whether in the state of oxyd or metal. This zink is always united to a certain quantity of lead. It seems that the zink prepared
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in China, which comes to us under the name of *tutenag*, is much purer, but the manner of preparing it is unknown with us. Sage states, that the English obtain zink in the large way, from lapis calaminaris by distillation, but the method is kept a secret.

Zink has neither taste nor smell. It cannot be reduced into powder like the other metals, but becomes flattened under the hammer, and may even be laminated, provided it has not previously been too much hammered. This experiment was made by Sage. When it is required to have zink in a state of extreme division, it must be granulated, that is to say, poured melted into cold water, or else reduced into filings. It has the inconvenience of choking up the files. Macquer affirms, that, when heated nearly to melting, it becomes very brittle, and may then be pulverized. This property is very different from that of the other metals, which become more ductile by the action of heat, and affords an advantageous process for obtaining zink in a state of extreme division. It may likewise be obtained in this state by triturating it while melted, and keeping its particles asunder by continual motion, before they take the solid form by cooling. This operation must not be made in an iron mortar, because zink always dissolves a portion of this metal; a mortar and pestle of marble must be used.

Mongez succeeded in obtaining this metal in a regular form; for this purpose he used a vessel pierced at the bottom and at its sides with a number of holes which he stopped with earth of bones. When the zink cools at the surface, the holes are to be opened gradually, and the metal agitated by a red-hot iron, introduced through one of these openings. This simple process occasions the melted portion of the zink to run out; the vessel is then to be shaken, till no more melted metal runs out, and the cold portion crystallizes. If it be left in the vessel,

vessel, it retains its metallic colour; but, if it be exposed to air, it takes a tarnish of rainbow colours. When zink is melted with contact of air, it becomes covered with a grey pellicle, which is quickly converted into a yellowish oxyd, and easily reducible. This oxyd weighs more than the zink made use of; but, if the metal be strongly heated, it burns with a white or light greenish yellow flame, very brilliant, and similar to that of phosphorus. The current of this flame drives up the oxyd of zink, which is condensed in the air in the form of white and very light flocks, named *flowers of zink*, *pompholix*, *nihil album*, *philosophical wool*, or *cotton*.

The following is La Grange's process for obtaining this white oxyd: place a large crucible upon two bricks in a good furnace; let the crucible be inclined at an angle of about 45° ; fix the cover of the crucible so that it may easily be closed when necessary. Put zink in the crucible, and urge it to fusion with a fire capable of maintaining a white heat, and keep the crucible shut. When it is very hot, uncover the crucible, and a perfect white flame, very vivid, rises from the surface of the zink; at the same time arises a very white flaky matter like cotton: this is white oxyd of zink. Take this away with a long-handled iron spoon; more is immediately formed, which is to be taken away in like manner, till all the zink is converted into oxyd. This oxyd is not volatile, though it rises in the manner of volatile bodies; it is, on the contrary, extremely fixed by fire. This oxyd may be melted into glass, but it requires an intense heat: the vitrified oxyd will be of a fine yellow colour, and not reducible by charcoal, or any other combustible body. Zink is scarcely alterable by the air. Its surface tarnishes a little, and appears to suffer a slight beginning of oxydation.

Gold and zink melt easily together. Equal parts
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of these metals form a hard brittle mass, which receives an excellent polish. This zink may be separated from the gold by oxydation in the fire, or by solution in nitric acid. Zink unites easily with platina, and forms with it a brittle hard bluish-coloured mixture. It is very difficult to separate it entirely from the platina by roasting.—Silver forms a brittle mass with zink, which, like that with gold, may be decomposed in the fire. The silver is precipitated by zink from its solution in nitric acid, partly in an oxydated and partly in a metallic state. A portion of the zink, however, falls along with the silver.—To combine lead with zink it is necessary to cover the mixture with charcoal, and to exclude from it carefully the external air. Zink precipitates lead from acids. Very beautiful *metallic vegetations*, as they have been termed, may be produced by suspending a bit of zink in a solution of acetat of lead.

Zink, in filings, or in powder, causes nitre to detonate with singular rapidity. The mixture being very dry, and thrown by spoonfuls into a red-hot crucible, produces a white and red flame. The activity of the inflammation is such, that portions of burning matter are thrown to a distance out of the crucible, in such a manner as to require some precaution on the part of the operator. The zink burns by the assistance of the oxygen afforded by the nitre, and is afterwards found in the state of an oxyd, more or less perfect, according to the quantity of nitre used.

Zink is of great use in the arts. It is employed in many alloys, especially in tombac, ruchbec, or prince's metal. Fine filings of zink are used to produce the white and brilliant stars in fire-works. The German physicians employ the sublimed oxyd of zink with success as an antispasmodic in convulsions and epileptic fits. *Pompholix*, *tutty*, or the different oxyds

of zink, are used as excellent desiccative medicines, to be externally applied in disorders of the eyes.

LOOSE OR FRIABLE ZINK, *Zincum ochraceum*.

Powdery, white, without lustre. Found in China, Sweden, and Carinthia; and used in the formation of the metal called *tutenag*.

CARBONAT OF ZINK, *Z. vitreum*.

Hard, transparent, of a glassy lustre. Many mineralogists do not admit this as a distinct species; and all allow that in external characters it very closely resembles the native oxyd, or calamine. It is found in Derbyshire and Somersetshire, Carinthia and Siberia, sometimes in solid masses, sometimes stalactitical or crystallized: colour grey, with often a tinge of blue, green or yellow: it contains oxyd of zink 65.2, carbonic acid 35.2.

CALAMINE, OR OXYD OF ZINK, *Z. calaminaris*.

Soft, tinged with some colour, of a common form, an earthy texture, opaque, without lustre, totally soluble in nitric acid. Found in various parts of Great Britain, New Spain, Poland, Silesia, Saxony, Bohemia, Austria, &c. massive, disseminated, or variously imitative. Colour greyish, greenish, yellowish, reddish, or brownish: fracture earthy, sometimes splintery, rarely conchoidal: before the blow-pipe it decrepitates but does not melt, and sometimes effervesces with acids. Specific gravity 3.434 to 4.1. Combined with copper it forms several useful alloys: when the zink does not exceed a fourth part of the copper it makes *brass*, and becomes malleable and ductile: when three parts of zink are combined with four of copper it then forms *pinchbeck*, or *prince's metal*, of a deeper orange-colour than brass, and not so malleable.

Crystallized oxyd of zink, which is frequently
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met with in Somersetshire, Derbyshire, and Nottinghamshire, is distinguished from many of those substances called zeolites, in not swelling up into a spongy mass upon the application of the blowpipe: from carbonat of lime, by either not effervescing with nitric acid, or by becoming gelatinous when dissolved in it: from sulphat of lime and sulphat of baryt, by its solubility in acids. When crystallized it easily becomes electric by heat, and retains its electricity for some hours.

A singular form of oxyd of zink has lately occurred in those mines in Sweden which produce the grey ore of copper called *fahlertz*. It is principally a combination of oxyd of zink with alumine: its specific gravity is 4.66; and it is sufficiently hard to scratch glass. It is met with in octohedral crystals of an iron-grey colour, imbedded in a rock of the nature of compact talc. It is called *automalite* or *automolite*.

BLLENDE, BLACK JACK, OR SULPHURET OF ZINK;
Zincum pseudogalena.

With a semi-metallic lustre, of a lamellar texture, emitting sulphurous flame and vapour before the blowpipe. There are three varieties of blende, yellow, brown, and black. Found in various parts of Great Britain, Siberia, Norway, Sweden, Germany, Hungary, &c. in various shapes and mixtures. When mixed with lead, it forms the metal called *tutenag*; and, combined with tin, it is an ingredient in *pewter*. We may add, that blende sometimes becomes phosphorescent by friction in the dark; and, according to Bergman, emits light as powerfully under water as in the air. The cause of the phosphorescence of blende is not known: it is sometimes excited by the slightest force.

Sulphuret of zink is one of the most common metallic ores; its matrix is very frequently quartz
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and carbonat or fluat of lime. When roasted, in order to expel the sulphur, it is used instead of calamine in brass-making. It almost always accompanies galena; which it sometimes so closely resembles, that, though the two substances are placed by each other's side, the eye can scarcely discern the difference: hence the name of *pseudogalena*.—Sulphuret of zink may be distinguished from most other substances which it resembles by exhaling a sulphurous odour, like that from Harrowgate water, when either triturated in a mortar or thrown into an acid.

BISMUTUM, BISMUTH.

GENERIC characters, Reddish-white, soft, brittle, composed of broad brilliant plates adhering to each other; specific gravity .9822: easily melting, and forming first a yellowish and then a red oxyd; in a strong heat burning with a faint blue flame and emitting a yellow smoke, fusible with borax into a brown glass: soluble in acids, and depositing a white precipitate if its solution in nitric acid be diluted with water.

NATIVE BISMUTH, *Bismutum nativum*.

Unalloyed, entirely soluble in nitric acid, with metallic lustre. Found in Sweden, France, Saxony, Wirtemberg, Transylvania, &c. generally accompanied by cobalt ores, in a matrix of red jasper, hornstone, quartz, and heavy spar: colour white with a shade of red, with the surface often tarnished red, yellow, or purple: sometimes it is crystallized in four-sided tables or indistinct cubes, but has mostly the form of small plates lying over each other: before the blowpipe it leaves a silvery-white bead, which at last evaporates in a yellowish-white smoke.

To reduce, or smelt, the ore of bismuth, a cavity is made in the earth, which is covered with billets of wood placed one on the other; the wood is set on fire,

fire, and the ore, being broken small, is thrown in it. The bismuth melts, and runs into the cavity, where it takes an orbicular form. In other places the trunk of a pine-tree, hollowed into the form of a gutter, is placed in the earth in an inclined position, and wood laid over it; the bismuth is thrown on this combustible matter, after it is set on fire: the metal melts, falls into the channel, which conducts it into a cavity made in the earth, over which the extremity of the trunk is placed. The bismuth, thus obtained, is poured into iron moulds. It is then of a light yellow colour, of a lamellous texture, and brittle; its metallic brilliancy is changed by exposure to the air, and it assumes a violet tinge; and at length a white powder is formed on the surface, which is bismuth in the oxyd state.

The nitrous solution of bismuth causes the metal to fall down in the form of a white calx, called *magistery of bismuth*. This precipitation of the nitrous solution, by the addition of water, is the criterion by which bismuth is distinguished from all other metals. The magistery, or calx, is a very white and subtile powder; when prepared by the addition of a large quantity of water, it is called *pearl-powder*, and is used by the ladies as a pigment for rendering the skin white; but it has the inconvenience of becoming black when in contact with odoriferous or combustible matters. This property has occasioned many a painful struggle between black, white, and red.

Hair-dressers, when they are desirous of converting hair into a black colour, smear it with a pomatum made of the magistery of bismuth, or with the soft fusible saline combination, called *butter of bismuth*. The white powder, called pearl-powder, mixed up with the white of an egg, and applied to turned wood, makes it look as if it had been silvered, after being well dried, and rubbed over with a hard polisher. It amalgamates

amalgamates with mercury, and forms a fluid alloy; whence some unprincipled druggists mix it with that metal; a fraud which should be prohibited, because it almost always retains a portion of arsenic. This property, however, of amalgamating with mercury, renders it of great advantage in silvering of glasses, by an amalgam of tin, bismuth, and mercury, whence it obtained its ancient name of *tin glass*.

Its various solutions form sympathetic inks, which are more or less curious, on account of the facility with which they are made visible. Any of the solutions of bismuth will do; but we should choose in preference an acid which will not corrode the paper, as the acetit of bismuth. Write the characters on the paper, and they will be invisible; to make them appear, take an alkaline sulphuret, (the sulphuret of ammoniac in preference;) putting this in contact with the paper, the vapour disoxygenates the bismuth, and blackens it, forming a sulphuret of bismuth. The experiment may be made by putting the sulphuret of ammoniac in a glass, and inverting the paper over it; the vapours of the sulphuret will rise, and soon render the characters visible.

We have already observed, that the oxyd of bismuth is used as a pigment for the skin, and that strong-smelling matters alter its colour; such smells as are fetid more particularly produce this effect. The vicinity of slaughter-houses, of common sewers, and almost every other strong smell, has that effect on this oxyd, and causes its colour to become more or less black; and hence it injures the skin. The vapour of alkaline sulphurets, or the smell of eggs, produce this effect quickly. A very common experiment in natural philosophy shows this property in a striking manner. If characters be written with a solution of bismuth on the first page of a book of fifty leaves, and the last page be impregnated with a small quantity of the liquid alkaline sulphurets, a
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short time afterwards, the hepatic vapour carried by the air, which circulates between all the leaves, arrives at the other extremity of the book, and converts the colourless characters, marked even on the first page, into a deep brown. It is affirmed, that the sulphurated hydrogen, or hepatic gas, passes through the paper; but Monge has proved, that it is the air which carries it in this manner, from one leaf to another, since the effect does not take place when the leaves are glued together.

OXYD of BISMUTH, or BISMUTH OCHRE, *B.*
ochraceum.

Friable or powdery, very soft, earthy, effervescing with acids. Found usually accompanying other ores of bismuth, sometimes compact or disseminated, but generally covering the surface of other ores in a loose friable form: colour yellowish-grey, passing into ashy-grey, green, or yellow. It is sometimes found crystallized in cubes or four-sided plates.

SULPHURET of BISMUTH, *B. sulphuratum.*

With metallic lustre, tin or steel-grey, not entirely soluble in nitric acid, emitting sulphurous flame and smoke when thrown on hot coals. There are two varieties: 1. Yellowish-white, shining, combined with arsenic and sulphur. 2. Bluish-white, laminar, combined with sulphur only. Both are found in the mines of Great Britain, Sweden, Saxony, Bohemia, and Hanover, generally accompanied by quartz, asbestos, or sparry iron-ore, massive or dispersed, seldom in acicular or capillary prisms: colour from tin-white to lead-grey, with the surface often iridescently tarnished: texture lamellar or radiated: contains from 60 to 95 per cent. of bismuth.

STIBIUM, ANTIMONY.

GENERIC characters, Of a silvery greyish-white colour, and radiately-lamellar texture; softish, and
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very brittle, when rubbed between the fingers giving them a peculiar taste and smell; specific gravity 6.86: melting at a red heat, and when gradually cooled exhibiting cubical crystals on the surface; in a greater degree of heat becoming first a greyish white oxyd, afterwards an hyacinthine glass, and lastly volatilizing in white vapours: forming a golden-yellow solution in nitro-muriatic acid, and depositing a white precipitate if water be poured into the solution.

The Latins called this metal *stibium*: it was first called *antimonium*, or antimony, in England, from its having been given to some monks, as a purgative. The prior of a monastery at Canterbury had given some of it to his hogs, and he found that it purged them and increased their appetite; he essayed to do as much by his monks, a lazy crew, who were often ill, and lost their appetites for want of exercise; but the greater part of them died, and the medicine was thenceforward called *antimoine*, or antimonk. Mines of all metals afford antimony: that in gold mines is reckoned best. It has also its own mines in Hungary, Germany, and France. It fuses in the fire, though with some difficulty; and dissolves more easily in water. It destroys and dissipates all metals fused with it, except gold; and is therefore useful in refining. It is a common ingredient in speculums, or burning concaves; serving to give them a finer polish. It makes a part in bell-metal; and renders the sound more clear. It is mingled with tin, to make it more hard, white, and sound; and with lead, in casting of printer's types, to render them more smooth and firm. It is a general help in the melting of metals, and especially in casting of cannon ball.

Antimony found its way into medical practice with great difficulty; the ancients considered it as a poison, and only fit for external uses. Basil Valentine, in the fifteenth century, first brought it into vogue

vogue as an internal medicine; he published a work called *Currus triumphalis Antimonii*, the Triumphal Chariot of Antimony; but it soon lost its repute, until Paracelsus raised its credit again, after which it was received and rejected several times, until at length it acquired an established place in regular practice; and is now justly ranked with the most valuable part of the materia medica. In its crude state, notwithstanding what has been said by many authors of its efficacy in rheumatic, cancerous, and other, cases, it appears from repeated trials to be an inert substance: but its preparations are used both as alteratives and evacuants, and hardly any article in the materia medica will admit of so extensive a use in acute diseases, as well as chronical. In fevers of the inflammatory and putrid kinds, antimonials are alike the proper remedy; and in chronical diseases, whether from the rigid or lax habit, they may be depended on. They promote all the secretions and excretions, particularly those of the skin, intestines, urinary passages, and salival ducts, by gently irritating the whole nervous and vascular compages. If given in small doses, gradually increasing them, yet keeping to that proportion which excites no sensible discharge, they are efficacious in regenerating a healthy state of the blood; for this purpose their effects are not so speedy as those of iron, but they are more lasting. Thus it is easy to perceive how justly it is asserted that antimonials are curative in so many disorders, and those too of opposite natures. As auxiliary to other medicines, on which the cure more directly depends, their efficacy is no less to be admired; they quicken their action and increase their powers, particularly those by which any evacuation is to be promoted; mixed in underdoses with such medicines, their operation is generally more easy too; as an expectorate, some of its preparations excel; and provoke the salivary discharge

charge in the same manner as when mercury hath been freely taken; but that made by antimony is ropy, whereas that with mercury is very thin. If any preparation of antimony is too free in its operation upwards, it may be carried through the intestines by taking a little common salt in any small drink made warm, or it is restrained by a draught of water acidulated with the acidum vitrioli dilutum. The preparations of this drug are very numerous, for the most important of which see Sulphuret of Antimony, p. 630.

NATIVE ANTIMONY, *Stibium nativum*.

Of a tin-white lustre, melting without sulphurous or arsenical vapours. Found in the mines of Sweden, and in Dauphiny, in irregular masses or kidney-form pieces: texture lamellar, with straight foliations: it deflagrates with nitre, and melts and evaporates before the blowpipe, leaving a white oxyd: when dissolved in nitro-muriatic acid, it deposits a dark-red precipitate by the addition of sulphurated ammonia: contains antimony 98, silver 1, iron 0.25.

ARSENIATED ANTIMONY, *St. arsenicale*.

Of a tin-white lustre, emitting arsenical vapours when heated. Found in Dauphiny, Hungary, and Saxony, in irregular masses: contains about 16 per cent. of antimony.

RED ANTIMONIAL ORE, *St. rubrum*.

Dull red, fibrous, a little shining, emitting sulphurous and arsenical vapours before the blowpipe. Found in the mines of Bohemia, Saxony, Hungary, and Transylvania, in the form of capillary crystals grouped together, often diverging in a radiate manner: texture fibrous, very soft, brittle: specific gravity 4. Contains oxyd of antimony 78.3, sulphur

phur 19.7, and (according to Dr. Kidd) some hydrogen. He calls it *hydro-sulphuret of antimony*.

PLUMOSE ANTIMONIAL ORE, *St. argentigo*.

Fibrous, leaving a silver bead before the blowpipe, and emitting sulphurous vapours. Found in France, Sicily, Transylvania, Bohemia, Hungary, Saxony, &c. generally on other ores or stones in the form of capillary straight or flexuous fibres, which are loose or cohering, parallel or disposed in a divergent manner, and soft like wool: it is a little shining, friable, and stains the fingers. Colour dark blue, grey, or white. It consists of antimony, iron, sulphur, and a little silver and arsenic.

OCHRE OF ANTIMONY, *Stibium fibigo*.

Fibrous, a little shining, emitting sulphurous vapours before the blowpipe, and entirely evaporating in a more violent heat. Found in Saxony, Bohemia, Hungary, Dauphiny, &c. sometimes friable and earthy, but generally covering the surface of other antimonial ores in the form of soft downy capillary flexible fibres, which are loose or bundled together, or stellately disposed. Colour blackish, grey, liver-brown, dull red, violet, greenish, straw-yellow, or variegated, rarely white: it does not melt before the blowpipe, but evaporates and deposits a white powder: with borax it effervesces, and is partly reduced.

SULPHURET OF ANTIMONY, *Stibium vulgare*.

Of a steel-grey colour and metallic lustre, ponderous, emitting sulphurous vapours before the blowpipe, and at last evaporating in white vapours. There are many varieties. Sulphuret of antimony is found in almost every country of Europe, massive, disseminated, or superficial, generally in matrices of quartz, lime, alumine, fluor, or barytes: it often
stains

stains the fingers, and before the blowpipe melts with a blue flame, leaving a grey oxyd of antimony.

The mixture of sulphuret of antimony with potash, forms a preparation known under the name of *kermes mineral*. The name of *kermes* was given to it by a Chartreux friar, named Simon, doubtless on account of its colour, which resembles that of the animal called *kermes*, which is employed in dying. *Kermes mineral* has likewise been called *Poudre des Chartreux*, because it was first prepared by persons of that religious order. The discovery of this medicine is due to Glauber, who prepared it with sulphuret of antimony and a solution of nitre fixed by coal; but he has described his process in an unintelligible manner, and almost entirely under alchemistical emblems. Lemery, who laboured much with antimony, and who has given us a preparation analogous to *kermes*, under another name, may be regarded as the true inventor. This remedy, however, was offered to the public as an intirely new invention many years after the publication of the works of that chemist, and, in fact, owes its celebrity to the singular cures effected by means of it in the hands of brother Simon. This friar had the composition from a surgeon, named La Ligerie, who was not himself the inventor. This last affirmed that he received it from Chastenay, lieutenant in the army at Landau, to whom it had been communicated by an apothecary, who pretended to be a disciple of Glauber. Dodart, then first physician to the French king, applied to La Ligerie to publish the receipt of *kermes*, which he accordingly did in the year 1720. Lemery the younger claimed the discovery in the name of his father in the Memoirs of the Royal Academy, and with great justice, as most chemists still make use of the process invented by him for the preparation of this remedy.

If any acid be poured into the liquor from which
kermes

kermes has been produced, after it has been entirely separated by cooling, and will furnish no more, this liquor becomes again troubled, and a yellow orange precipitate of sulphurated oxyd of antimony, called the *golden sulphur of antimony*, is produced. The liquor being filtered, the orange-coloured sulphurated oxyd of antimony may be precipitated anew by means of acids; but this second precipitate will by no means have so bright a colour as the first.

Kermes mineral is one of the most valuable antimonial remedies we are in possession of; it is attenuating, and is employed with the greatest success in pituitous affections of the stomach, the lungs, the intestines, and even the urinary passage. It is most commonly used in disorders of the breast to assist expectoration. It ought not, however, to be administered till after the inflammation is abated. It has likewise great success when given in repeated small doses in catarrhs of the breast, the humid asthma, maladies of the skin, glandular swellings, &c. It is administered in a dose from half a grain to two or three grains in proper liquids, or made up in pills. It sometimes causes vomiting, and very frequently acts as a sudorific or a diuretic.

The golden sulphur, on account of its being a violent emetic and cathartic, is not much used. It was formerly given in the same disorders as the kermes, but its effects are much more uncertain. There are also many other preparations of antimony, which are used in medicines to great advantage. This metallic substance is one of the most important in the materia medica, and physicians cannot pay too great an attention to its properties.

PHOSPHORATED ANTIMONY, *Stibium phosphoratum*.

In acicular, scattered, lamellar, longitudinally-streaked, crystals, not inflaming, and yielding very little smoke before the blowpipe. Found in Savoy,
in

in the cavities of a vein of sulphuret of antimony: colour white, yellow, or blackish: soft, flexible, and easily cut. It appears to be sulphuret of antimony combined with phosphoric acid.

WHITE ORE OF ANTIMONY, OR MURIATED ANTIMONY, *St. muriaticum*.

White, shining like mother of pearl, radiate in a parallel manner, in the form of small erect four-sided tables. Found in Bohemia, Saxony, Dauphiny, and Hungary; it is totally soluble in nitro-muriatic acid, decrepitates in the fire, and easily melts when powdered, evaporating in a white smoke: with borax it leaves a metallic bead: according to Klaproth it is nothing more than a white oxyd of antimony, containing oxyd of antimony 86, oxyde of antimony united with oxyd of iron 3, filix 8.

TELLURIUM, TELLURIUM.

GENERIC characters, Colour between tin and lead, soft, very brittle, and easily reducible to powder, of a lamellar texture; specific gravity 6.115: melting in a heat somewhat above the fusing-point of lead, and, if the heat be a little increased, boiling and evaporating, attaching itself in brilliant drops to the upper part of the retort; before the blowpipe burning with a lively blue flame, the edges of which are green, and at last evaporating in a white smoke smelling like radishes: partly soluble in concentrated sulphuric acid, and giving the solution a crimson red colour, which precipitates a white powder on the addition of a large quantity of water.

As the alchemists distinguished metallic substances by the same names that the ancients had applied to the planets, the principle was extended in the present instance; and the metal under consideration was named by Klaproth from our own planet the earth, or Tellus. Tellurium, has but recently been discovered;

covered; and, as it was met with in some of the ores of Transylvania, it has sometimes been called Silvanite. In these ores it is united with gold, and iron, and other metals. From the white colour of the alloy in some of the varieties, it has been called *white gold*; and as at first there were great doubts respecting the nature of the ore altogether, and the state in which the gold existed in it; or whether it was to be regarded as a chemical constituent part; it has also been called *aurum problematicum*, and *aurum paradoxum*.

NATIVE TELLURIUM, *T. nativum*.

Soft, heavy, somewhat ductile, with metallic lustre. Found in the mine of Mariahilf in the Facebay mountains of Transylvania, massive and disseminated: contains tellurium 92.55, iron 7.2, gold 0.25.

GRAPHIC TELLURIUM, *T. graphicum*.

Tin-white, or inclining to yellow; soft, brittle, staining a little, in small prismatic crystals often grouped in such a manner as to resemble written characters. Found in the Franciscus mine at Offenburg in Transylvania, with metallic lustre.

WHITE TELLURIUM, *T. album*.

Silver-white passing into brassy yellow; soft, heavy, somewhat ductile with metallic lustre. Found in the Nagyag-mine of Transylvania, disseminated or crystallized in small four-sided prisms: fracture in one direction foliated, in the other uneven. Contains tellurium 44.75, gold 26.75, lead 19.5, silver 8.5, sulphur 0.5.

FOLIATED TELLURIUM, *T. bracteatum*.

Between lead-grey and iron-black, in flexible plates or six-sided tables, with very little metallic lustre. Found at Nagyag in Transylvania, and is wrought

wrought for the gold which it contains: it is soluble in acids with effervescence. Specific gravity 8.918. Contains lead 54, tellurium 32, and a little silver and copper.

ARSENICUM, ARSENIC.

GENERIC characters, Bluish-white, soon becoming black, and falling to powder in the air; soft; extremely brittle, specific gravity 8.31: subliming without melting, in a moderate heat, in a white powder emitting a strong smell resembling garlic: its sublimed oxyd giving an acrid taste to water, and turning vegetable blues red; when dissolved in muriatic acid, and a watery solution of sulphurated hydrogen poured into it, precipitating a fine yellow powder.

The word *arsenic* is derived from the Greek *ars*, a man, or *arsen*, male, and *nikan*, I kill. Arsenic appears to exist in the metallic state in combination with cobalt in the testaceous cobalt ore, or with iron in mispickel. It is often combined with metals in various ores, and is disengaged from them by calcination. In various mine-works, long winding chimneys are constructed, through which the arsenical vapours pass, and in which they attach themselves. The crust, which from time to time is formed against the internal surface of these chimneys, is taken away, and is the deadly poison sold in the shops under the name of arsenic. The cobalt ores of Saxony, which are torrefied to separate the metal, afford almost the whole of what is sold. This oxyd or calx of arsenic may be found native, and very abundant, in such places as are situated in the vicinity of subterranean fires, such as the solfatara, &c.

Motherby, in his new Medical Dictionary, says of arsenic, "that it produces speedy dryness in the throat, and inflammation, dejection, fainting, stupor, delirium, tremors, convulsions, palsy, thirst, burning

ing in the stomach, gripes, vomiting, cold sweats, hiccoughing, and at last death. Besides the effects which it has in common with other poisons, it remarkably attenuates the coats of the stomach, and perforates the intestines, occasions a swelling and sphacelation of the whole body, and a sudden putrefaction after death, and particularly of the pudendæ. When the quantity taken is not fatal, it occasions tremors, palsies, or lingering hectic. And, though there is but little hope after this poison is swallowed, yet, if assistance is to be had (says Dr. Motherby), immediately give a scruple of the white vitriol (sulphat of zink) to excite a vomiting, and repeat it two or three times; give the patient plentifully of warm water mixed with sweet oil, after each dose of the vitriol, that if possible the stomach may be well cleared of the poison; large draughts are peculiarly proper, as they distend the stomach, and so more effectually wash away what may be lodged in its villous rugæ. After sufficient vomiting, give mucilages and demulcents, particularly plenty of gum arabic, new milk, and oil, both by the mouth and clysterwise; fat broth should be continued for some time, and the bowels must be kept lax. If the poison has had time to get into the blood, let cordial perspiratives be added, such as rad. serpent. &c."

Arsenic is used in many of the arts; in washes for whitening of metals; in glass-houses, for melting; and in mining; it also enters into the composition of some kinds of varnish. The oxyd of arsenic was formerly much used in dying, particularly in painted cloths; but its inutility is now acknowledged. Orpiment is however employed in some of the processes of dying, especially with indigo. Orpiment and realgar are much used in painting: but, in general, arsenic is one of those productions whose advantages hardly compensate for its deleterious effects.

NATIVE ARSENIC, *A. nativum*.

Uncombined, with metallic lustre. There are three varieties. Native arsenic occurs in Great Britain, various parts of Germany, Norway, Saxony, &c. accompanying spar, barytes, or feldspar; massive, rarely disseminated, often composed of hemispherical layers, corroded, branched, perforated, botryoidal, or stalactitical: colour lead-grey, but its surface soon tarnishing and becoming black by exposure to the air: sometimes a little sonorous when struck against a hard body, and so soft as to be easily cut with a knife: before the blowpipe it immediately emits a white smoke, diffusing its peculiar and highly poisonous vapours to a great distance, burning with a blue flame and gradually vanishing, depositing a white oxyd in the form of a powder: specific gravity to 5.7. It is always alloyed with iron, and often contains cobalt, bismuth, silver, and sometimes a little gold.

WHITE OXYD of ARSENIC, *A. calciforme*.

White, soluble in 80 times its weight of water. There are three varieties: they are found in various parts of Great Britain, Germany, Hungary, Saxony, Bohemia, &c. either in powder or massive, or crystallized in prismatic needles. Colour white or grey, with often a tinge of red, yellow, green, or black: before the blowpipe it sublimes but does not inflame, and tinges borax green: specific gravity 3.7.

YELLOW ARSENIC, or ORPIMENT, *A. auripigmentum*.

Ponderous, yellow, curved or undulately foliated, of a waxy internal lustre, evaporating almost entirely before the blowpipe.

It is called *auripigmentum* from its golden yellow colour, and the use to which it is commonly applied.

plied. This substance, which is the *arsenic* of the ancients, differs from the substance commonly called arsenic at the present day, in containing a portion of sulphur; and in being consequently of a yellow colour: whereas our arsenic is perfectly white. That the arsenic of Theophrastus and Pliny was of a yellow colour is evident from the particular description which they give of it. Pliny says that the best arsenic is, "coloris in auro excellentis:" Theophrastus says that, on account of its resemblance in colour, ochre (*ωχρεα*) is used instead of arsenic: but the term *ωχρεα* itself is apparently derived from its yellow colour; and that it was of this colour appears further probable, from its being changed to a red by calcination, which is mentioned by Theophrastus, and being thus converted into the substance called *μολτος*, which answers exactly to our red ochre. The term *αρσενικον*, from which our word arsenic is derived, was an epithet applied by the ancients to those natural substances, the properties of which were found to be of a strong, and as it were *masculine*, character: and, as the poisonous quality of arsenic was soon found to be remarkably powerful, the term was especially applied to that form of it which was most commonly met with. The arsenic of commerce of the present day is in some instances of a yellow colour; and as the ores, from which white arsenic may be obtained, very commonly contain sulphur, the presence of this yellow colour is easily explained: for the orpiment of commerce, which is valuable on account of its yellow colour, is obtained by subliming together either a mixture of white arsenic and sulphuret of iron, or of sulphuret of iron and any mineral containing a considerable proportion of arsenic. Orpiment is met with in the cavities of many volcanoes: and in the substance of many primitive rocks. It occurs in great abundance in Saxony, Bohemia, and Hungary. Orpiment is distinguished from native

native sulphur by its laminated structure, and by the garlic smell which it emits upon the application of the blowpipe: the last property serves also to distinguish it from yellow mica.

RED ARSENIC, REALGAR, OR SANDARAC, *A.*
Sandaraca.

Somewhat ponderous, red with an orange-yellow streak, in straight foliations, melting easily before the blowpipe, burning with a blue flame and white arsenical vapours. Found in Sicily, Naples, Hungary, Bohemia, China, Japan, &c. massive, disseminated, superficial, or crystallized in small acutangled quadrangular or acicular prisms. Colour aurora-red, ruby, scarlet, crimson, or blood-red, often variegated with yellow traces: texture lamellar, with the foliations a little flexible, and so soft as to be cut with a knife, and frequently exhibiting a brilliant lustre: streak yellowish-red, powder scarlet: in nitric acid it loses its colour. Realgar is distinguished from red silver ore, and chromate of lead, by its inferior specific gravity, 3.338; from cinnabar, by the yellowish-red colour of its powder; that of cinnabar being a bright red. The strong smell of garlic, and the white fumes which it emits upon the application of the blowpipe, are in themselves strong distinctive marks between this substance and others with which it is liable to be confounded by the eye.

ARSENICAL PYRITES, OR MARCASITE, *A. sulphuratum.*

Hard, bluish-grey with metallic lustre, before the blowpipe emitting white arsenical vapours and blue sulphurous flames. Found in various parts of Great Britain, Germany, Sweden, Bohemia, Saxony, &c. in irregular masses, disseminated, investing, or crystallized in cubes or four-sided prisms: colour greyish-white, often a little variegated: texture uneven, sometimes

sometimes granular, sometimes lamellar or radiate: when rubbed it gives the odour of garlic. Specific gravity 6.522. Contains arsenic 53, iron 19.7, sulphur 15.3, silica 12.0.

FERRUGINOUS ARSENIC, or MISPICKEL, *A. albicans.*

Of a steel-white colour and lustre, hard, emitting white arsenical vapours before the blowpipe, but no sulphurous flame or vapour. This form of arsenic is very common in the tin-mines of Cornwall. The white oxyd of arsenic, which is the white arsenic of commerce, is often obtained from it, by submitting the ore to the process of roasting, and collecting the volatilized oxyd in flues connecting with the chambers in which the ore is roasted. This ore very much resembles the native alloy of cobalt and arsenic: the colour of the latter has often a faint shade of red, by which it may be distinguished; and its form is a modification of the cube, while that of the substance under consideration is prismatic.

ARGENTIFEROUS ARSENICAL PYRITES, *A. argentiferum.*

Of a silvery lustre and very fine granular texture, emitting arsenical vapours before the blowpipe, and when fused with lead leaving a silver bead. Found in the mines of Saxony, Bohemia, Germany, and Spain, massive, disseminated, or acicular. Colour nearly that of the last, but brighter and more permanent: it burns with a white flame, and leaves a reddish residuum. By solution in nitro-muriatic acid the silver will be precipitated. It consists of arsenic, sulphur, iron, and from 1 to 10 or 12 per cent. of silver. Specific gravity 4.

COBALTUM,

COBALTUM, COBALT.

GENERIC characters, Bluish-grey, with often a shade of red; hardish, very brittle; attracted by the magnet, and itself convertible into the magnet; specific gravity 8.15: in a red heat gradually becoming a blue powder, which becomes deeper, and at last a deep black-blue; in a violent heat burning with a red flame; when fused with borax, producing a fine blue glass: giving a reddish colour to its solution in nitric acid, and precipitating a blue powder with the addition of potash.

Cobalt was employed in manufactories to give a blue colour to glass, long before it was suspected to be a peculiar metal: this was first discovered by Brandt, a Swede. It has never yet been found pure and native; but mostly oxydated, and united with arsenic, arsenical acid, sulphur, iron, &c. It has never been possible to obtain cobalt in a state of purity; but Tassaert's method of treating the cobalt of Tunaberg, as inserted in the *Annales de Chimie*, may answer for fixing precisely the characters of this metal. Having obtained the oxyd of cobalt in a very pure state, his mode of reducing it is as follows: Take a porcelain crucible, which is to be lined with carbon obtained from carbonic acid; put in the oxyd of cobalt, and expose it for an hour and a half to a forge-furnace; let it cool, then break it, and a button will be found, of the colour of iron, brittle, which being broken exhibits a foliaceous texture like fern-leaves, of an iron-grey colour, without much metallic brilliancy. The specific gravity of this very pure cobalt, according to Haüy, is 8.5384; and this metal, though entirely deprived of iron, is still strongly attracted by the magnet. As this gentleman has not set down the other characteristics of this metal thus purified, our following remarks must be taken to refer to cobalt procured by the usual methods.

In

In the arts, and in the large works, cobalt is not extracted in the metallic form: after pounding and washing the cobalt ore, it is roasted in a furnace, which terminates in a long horizontal flue, that serves instead of a chimney. In this flue, the oxyd of arsenic, being sublimed, becomes condensed into the semi-vitrified substance, which is improperly called *white arsenic*. If the ore contain bismuth, this very fusible metal is collected at the bottom of the furnace; the cobalt remains in the state of an obscure grey oxyd, called *zaffre*. The *zaffre*, in commerce, is never pure, but is mixed with three times its weight of pulverised flints. In this state, if it be exposed to a strong fire, it melts into a glass, of a dark blue colour, called *smalt*. This is reduced to powder in mills, and mixed with water. The first portion which falls down, is the largest grained, and is called *coarse smalt*; the turbid water being decanted off, affords a second precipitate; and this decantation is repeated four times in the whole: the last deposition, which is finer than the rest, is improperly called *azure of four fires*. This *azure* is used in many arts, to give a blue colour to metals, glasses, &c.

A *sympathetic ink* may be prepared thus: Put into a matrass one part of cobalt, or rather *zaffre*, with four parts of nitric acid; let the mixture digest in a hot sand-bath for three or four hours, or till the dissolution is almost complete: then add as much muriat of soda as was used of cobalt, and of water four times the quantity of the nitric acid; filter the liquor through paper, and you have a *sympathetic ink*, with which, if you write upon white paper, no mark will be visible; but, by slightly warming it, the characters will appear of a beautiful sea-green colour; as the paper gets cold, the colour disappears, but may be revived again by heat.

Only the oxyd of cobalt is employed in the arts, not the metal. It is used in painting earthen ware
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and porcelain; former painters used it ground with oil, hence that very rough blue visible in the ground-work and draperies of old pictures; for the colour grows darker with age by contact with air. It is a colouring-matter for glass and enamel. Azure is used in dying cloth, in making starch, &c.

NATIVE OXYD of COBALT, C. nigrum.

Inconspicuous, of a dusky colour, emitting no arsenical vapours when thrown on hot coals. There are two varieties; one friable, of a loose earthy consistence; the other indurated. Found in the mines of Great Britain, Austria, Saxony, Hungary, Germany, &c. This ore, which does not often occur, is of a black colour, and earthy appearance; but, if rubbed with any hard substance, its surface becomes brilliant: and this is a very good distinctive mark of it. When pure, it is particularly valuable; as already existing in a fit state for the purpose of colouring glass, &c. without the necessity of being roasted.

COBALT OCHRE, C. ochraceum.

Inconspicuous, earthy internally, of a paler colour, emitting arsenical vapours when thrown on hot coals. There are three varieties of this, brown, yellow, and green. They are found in the mines of Great Britain and various parts of the continent, generally deposited on other ores, though sometimes found botryoidal, or kidney-shaped. Colour various shades of brown, reddish, yellowish, green or inclining to blue: it very readily forms a glass of various shades of blue.

ARSENIAT of COBALT, C. cobaltigo.

Radiated, red, with a glassy lustre, emitting arsenical vapours when thrown on hot coals. Found near the lakes of Killarney in Ireland, and in most places where the other ores of cobalt abound; sometimes massive, sometimes in the state of flowers: colour various shades of red, from pale peach-blossom
red

red to deep crimson: sometimes it is found deposited on different stones in the form of small four-sided prismatic crystals disposed in a stellate or radiate manner, which are shining, semi-transparent, and soft to the touch: it consists of cobalt combined with the arsenical acid.

DIRTY COBALT, *C. stercoreum*.

Inconspicuous, of a dirty mixed colour; when burnt and fused with lead, leaving a bead of silver. Found in the mines of Norway, Saxony, Germany, Hungary, and Dauphiny; contains a mixture of silver, iron, sometimes nickel, arsenic, rarely quicksilver, in such indeterminate proportions as to make it difficult to fix its genus.

SULPHURATED COBALT, *C. sulphuratum*.

Of a tin-white colour and lustre, emitting sulphurous vapours when thrown on hot coals, and at length leaving a pure oxyd of cobalt. Found in Sweden and Hungary, sometimes massive, sometimes in cubical crystals without striæ; and is composed of cobalt and sulphur with arsenic or iron.

WHITE COBALT ORE, *C. pyriticosum*.

Of a steel-white colour and lustre, emitting sulphurous vapours before the blowpipe, and when heated with powdered charcoal leaving a magnetic bead. Found in the mines of Sweden, Hungary, Saxony, Bohemia, &c. massive, disseminated, or crystallized in small four-sided prisms or cubes, or double quadrangular pyramids; texture generally fine-grained, rarely striated or divergently fibrous: contains cobalt combined with sulphur and iron.

GREY COBALT ORE, *C. crystallinum*.

Of a bluish-tin colour and lustre, emitting sulphurous and arsenical vapours before the blowpipe, and leaving a magnetic bead. Found in the mines of

Cornwall and various parts of Europe, of a dull grey colour, with the surface often tarnished: the crystals are usually six-sided prisms terminated at each end by an irregular six-sided pyramid, so that the crystal consists of six tetragons and twelve hexagons, with the faces striate in an opposite manner. It consists of cobalt combined with arsenic, sulphur, and iron, in various modifications. Specific gravity 6.38. It often strikes fire with steel, emitting at the same time a smell of garlic: its primitive form is a cube, the surfaces of which are remarkably brilliant. It contains cobalt 44, arsenic 55.5, sulphur 0.5. Cobalt alloyed with arsenic is reduced to the state of the simple oxyd of cobalt by the process of roasting: the oxyd is extensively used in the arts, for the purpose of giving a blue colour to glass, and enamels, &c. During the roasting, the arsenic is separated in the state of a white oxyd, and is deposited in flues communicating with the chambers where the ore is roasted. From the nature of the substance deposited, these flues are usually called *poison flues*; and probably from the same circumstance the German miners gave this metal the name of *cobalt*; which literally signifies *an evil spirit*. The white fumes and the strong smell of garlic emitted from this variety of cobalt, and its property of communicating a blue colour to glass of borax, distinguish it from all other minerals.

VIEGRI

MAGNESIUM, MANGANESE.

GENERIC characters, Dark grey, gradually blackening by exposure to the air; hard, very brittle, of a granular texture, attracted by the magnet when reduced to powder; specific gravity 7; melting with great difficulty, its black oxyd assuming a green colour, which in a very violent heat is fused and converted into a green glass; when fused with borax, producing a deep red glass; when dissolved

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in sulphuric acid, leaving a black spongy mass behind, and forming a red precipitate with the addition of soda.

Manganese was long unknown as a metal, though much used in the arts; it has been employed in glass-works for more than two thousand years. It has the property of whitening glass, or rendering it colourless; whence it has been called *soap of glass*. Scheele has proved, that the ashes of vegetables contain manganese; it is separated by treating with nitrat of potash; urging the mixture to fusion, a coloured glass, either blue or green, is obtained.

NATIVE METALLIC MANGANESE, *M. regulina*.

Staining the fingers, of a silver-grey colour with metallic lustre, and divergingly-foliated texture. Found in the valley of Viedessos, near Lem, in the neighbourhood of Foix, on the Pyrenees, in kidney-form masses: it is slightly malleable, and not attracted by the magnet.

MANGANESE OCHRE, *M. ochraceo*.

Friable, without lustre or transparency, earthy. Found in England, the Pyrenees, the mines of Franconia, and in the Altaic mountains of Siberia; massive or disseminated, cellular, porous, perforated, or in various imitative forms: texture earthy. Colour blackish, or brown like the brown hæmatites. Specific gravity, before it has absorbed water, 3.707; after absorption, 3.903.

BLACK WAD, *M. pictorum*.

Black, friable, floating; mixed dry with a fourth of its weight of linseed oil, producing spontaneous inflammation. Found in Derbyshire, forming considerable strata; friable, generally smooth between the fingers. Contains manganese, oxyd of iron, lead, and mica.

WHITE

WHITE ORE OF MANGANESE, *M. nivea*.

White, becoming brownish or blackish when heated; soft, effervescing with nitric acid and emitting sulphurated hydrogen gas. Found in the mines of Great Britain, Norway, Sweden, and Transylvania, in round or kidney-form masses, or variously disseminated, sometimes in loose scales. Colour white, with often a reddish tinge: texture either radiated or in incurved foliations: before the blowpipe it gives a violet colour to borax.

NATIVE OXYD OF MANGANESE, *M. vulgaris*.

Soft, staining the fingers, of a steel grey colour with metallic lustre. Found in various parts of Great Britain, particularly on Mendip-hill in Somersetshire; in Sweden, France, Germany, Bohemia, Silesia, &c. massive or disseminated, or variously imitative, in small acutangled quadrangular prisms or six-sided acicular columns with the faces often longitudinally striate. Colour greyish-white, more or less dusky, with sometimes a small tinge of red: texture seldom compact, generally fibrous in a stellate manner, radiated, or foliated, with the fragments indeterminate or wedge-form or splintery: soft, brittle, with a black or brown streak: before the blowpipe it becomes blackish-brown, but does not melt, and tinges borax violet.

The accurate experiments of Scheele, and those of Bergman, Gahn, Rinman, Engestrom, Isleman, La Perouse, and Fourcroy, have thrown great light upon the properties of this metallic substance. Melted under the blowpipe, with microcosmical salt, a transparent glass is obtained, of a bluish-red colour; if left to grow cold and melted again, slowly, the colour disappears; melted afresh with the outward flame of a blowpipe, the colour may be made to come and go alternately. By heating the native oxyd

oxyd alone in the pneumatic apparatus, very pure oxygen gas is obtained. It is this oxygen or vital air alone, which can be used to advantage by patients whose disorders require the administration of this fluid. It is to be remarked, that, in distilling the native oxyd of manganese, in order to obtain vital air in a very pure state, the retort must be completely filled with this substance, so as to allow no atmospheric air to remain in the retort. It is in this way that the vital air intended for the use of the sick, or for the composition of water, ought to be prepared. Without this precaution, a considerable quantity of nitric acid will be formed, or a mephitic residue produced, which stops the combustion of the hydrogen gas, and renders it necessary to empty the receiver. Nearly two quarts of oxygen gas may be obtained from an ounce of the oxyd.

By adding oxyd of manganese to the materials used in making glass, it is rendered of a clear white: the addition of nitrat of potash gives the glass a violet-colour, which will be so much the stronger, in proportion as the oxydation of the metal by the nitric acid was the more complete. Thus the oxyd of manganese is used in glass-works, either to take away the yellow, green, or blue, tinge, from glass intended to be of a clear white; or, in other proportions, to give the glass a violet colour. This substance is also an ingredient in printers' ink.—The affinity of manganese for the principle of combustion serves likewise to guide modern chemists in a great number of cases, and may lead to discoveries concerning the nature of many substances at present unknown. The specific gravity of this oxyd varies from 2 to $4\frac{3}{4}$: it contains from 30 to 45 per cent. of oxyd of manganese, from 30 to 40 of oxygen, and a small quantity of oxyd of iron, carbonat of lime, barytes, and silica.

BLACK

BLACK ORE OF MANGANESE, *M. nigra*.

Soft, staining the fingers, black with hardly any lustre. Found commonly in the mines containing the grey ore, or native oxyd; massive, investing, or variously imitative. Colour black or dark brown, sometimes with a bluish cast, and often variously coloured on the surface: texture earthy, compact, even or slightly conchoidal: in its composition it resembles the last, but contains more iron. Its crystals are usually eight-sided prisms, with their faces smooth.

PERIGORD STONE, OR COMPACT MANGANESE, *M. petracorius*.

Hardish, staining the fingers, blackish, shining internally, becoming red when heated. Found at Perigord in France, softish, of a compact texture, and brownish-black colour: when heated it hardens and becomes reddish-brown, but not magnetic, and gives a red or violet tinge to borax. Besides manganese, it contains alumine and iron.

RED ORE OF MANGANESE, *M. rosea*.

Pale rosy red, foliated, not staining the fingers, easily melting with effervescence. Found in the Nagyag mines of Transylvania, where it is the matrix of gold; and near Kapnik in Hungary; massive, loose, disseminated, or imitative, sometimes crystallized in rhomboidal prisms or needles: texture foliated in thin incurved layers, with the fragments often splintery. Colour pale rosy red mixed with white; powder whitish. It effervesces with nitric and muriatic acids, becomes reddish-brown when heated to redness, and tinges borax red. Contains filix 55, oxyd of manganese 35, oxyd of iron 7, and about 2 of alumine.

TUNGSTENUM,

TUNGSTENUM, TUNGSTEN, or WOLFRAM.

GENERIC characters, Greyish or brownish, internally steel-white; very brittle and hard; not attracted by the magnet; specific gravity 17.6: fusing with great difficulty, gradually changing from a black to a yellow oxyd when heated, which, with the addition of microcosmic salt, is at last converted into a blue glass; soluble in the nitric acid into a yellow oxyd.

The literal meaning of the word Tungsten is *heavy stone*. The metal was so called from the great specific gravity of the mineral, in which it was first discovered. It is also called *Scheelium*; in honour of Scheele, who first ascertained the real nature of this mineral. It exists in two natural forms; in one of which it is combined with lime; in the other, with iron and manganese: the first is usually called Tungsten; the last Wolfram.

TUNGSTAT OF LIME, or TUNGSTEN, *T. calcareum*.

Ponderous, lamellar, extremely brittle, yellowish-white or grey, digested with hot nitric acid becoming yellow. Many of the specimens of tungsten met with in cabinets come from Zinnwalde in Bohemia; and are accompanied with mica crystallized in hexagonal plates, and with smoky quartz. Numerous minute crystals of tungsten sometimes incrust the surface of the latter substance. Tungsten is also met with in Cornwall; and in Sweden. It usually accompanies tin-ore and wolfram. It was at first mistaken for a white variety of native oxyd of tin; from which it may be distinguished by the change of colour it undergoes when thrown into nitric acid. It is distinguished from carbonat of lead by not effervescing with an acid, and in not being blackened by an alkaline sulphuret: from sulphat of baryt, by its greater

greater specific gravity; and by the yellow colour it assumes when thrown into nitric acid. Specific gravity from 5.8 to 6: contains oxyd of tungsten 70, lime 30.

TUNGSTAT of MANGANESE, or WOLFRAM,
T. magnesiatum.

Very ponderous, lamellar, opaque, of a blackish-brown colour and reddish-brown streak, forming a greenish glass with borax. Specific gravity 7; contains oxyd of tungsten 65, oxyd of manganese 22, oxyd of iron 13.

Wolfram is one of those minerals whose equivocal effect occasioned it to be often ranked with different species, to which it seemed to have some resemblance; so that it was long before it obtained a permanent place. Henckel says, that at Altenbury in Misnia, it was erroneously called antimony; hence, perhaps, the name of *wolf's foam*, or *wolfram*. Many naturalists regarded it as a schorl abounding in iron; others considered it as an arsenical ore of iron; Wallerius thought it a species of manganese. But d'Elhuyar, Vauquelin, and Hecht, put an end to these conjectures, by proving that wolfram contains a metal of a peculiar nature, which is tungsten.

Wolfram is drawn from the mines of Saxony, Bohemia, and Sweden. It often accompanies crystals of tin, which are also of a blackish colour, but differs materially from it. It has been found in France also, in the department of Haute Vienne, in the canton and commune of St. Leonard, and at Puy-les-Mines. It easily yields to the file, and then exhibits a brown colour, slightly tinged with violet, where the file has passed: the dust, rubbed upon paper, exhibits spots of the same colour. It is composed of brilliant laminæ, which are easily separated by percussion. It is very slightly electric, and does not attract the magnetic needle.

MOLYB-

MOLYBDÆNUM, MOLYBDENA.

GENERIC characters, Bluish-grey, not tarnishing; brittle, not magnetic, composed of scaly particles cohering together, specific gravity 7.5: nearly infusible, gradually becoming a white volatile oxyd when heated, which with borax forms a violet, and with microcosmic salt a green, glass: partly soluble in sulphuric acid, and giving the solution first a green and then a blue colour.

Certain substances have long been confounded under the names of black-lead ore, mineral lead, plumbago, or molybdena, which the more exact analysis of Scheele has proved to be of a different nature. Molybdena can now no longer be confounded with that ore of which drawing-pencils are made, called black-lead; the differences are so obvious, that no doubts can remain. Molybdena is composed of hexagonal scales, of greater or less size, very slightly adhering to each other: it is soft and fat to the touch, soils the fingers, and leaves traces upon paper, which are bluish, or of a silvery grey colour; the traces from plumbago are darker and rougher. When it is reduced to powder, which is difficult to be performed, on account of the elasticity of its scales, it has a bluish colour; it yields easily to the knife, is not brittle, and has not the granulated texture of black-lead, or Graphites plumbago, which see described at p. 528.

Molybdena occurs in two forms only: firstly, in an acid state united with lead, for which see p. 608, secondly, combined with sulphur, and thence called

SULPHURET OF MOLYBDENA, *M. vulgare*.

Found in France, Spain, Sweden, Saxony, Siberia, and Iceland, in gangues of feldspar, lithomarg, or quartz, generally in masses consisting of small grains agglutinated together, sometimes crystallized in six-

sided tables. Colour light lead-grey, with sometimes a shade of red; streak bluish-grey, metallic; powder bluish: soft, opaque, staining the fingers, and feeling a little greasy to the touch. Texture lamellar, with the foliations thin, incurved, and slightly flexible. With warm nitric acid it effervesces, leaving a grey oxyd undissolved; before the blowpipe it evaporates in white sulphurous vapours. Specific gravity 4.738: contains molybdenum 60, sulphur 40.

URANIUM, URANITE.

GENERIC characters, Dark-grey inclining internally to brown, with a slight lustre; soft, brittle: specific gravity 6.44: hardly fusible before the blowpipe, but with borax forming a brown and with microcosmic salt a grass-green glass: convertible into a yellow oxyd by the nitric acid. This metal was lately discovered by Klaproth; it has not yet been found native. Klaproth called it Uranite, or Uranium, from Uranus, the name which Bode gave to Herschel's newly-discovered planet, by us called the Georgium Sidus. Klaproth detected this metal, combined with a certain mineral, found in a mine belonging to George Wagsford, at John-georgenstadt, in Germany. Its discoverer, Klaproth, to whom we owe its analysis also, first extracted it from sulphur; then he dissolved it in the nitric and nitromuriatic acids, and precipitated by alkalies; he obtained precipitates of a lemon or orange colour: with ammoniac, the precipitate is of a dirty yellow. For the reduction of this metal, separate the yellow precipitates from the solution by means of acids; make a paste of them with linseed-oil, which put into a roasting-furnace; a black powder is obtained, which is to be put in a crucible, well secured with charcoal, and exposed to a strong heat. These experiments are not very conclusive, because the metal has never been

been yet obtained in large quantities; so that it is not easy to discover all its properties.

URANITIC OCHRE, *U. ochraceum*.

Yellowish or green, of an earthy texture, entirely soluble in nitric acid, combined with a large portion of oxygen. Generally found on the surface of *U. sulphureum*, or pechblende, in Cornwall, &c. It slightly stains the fingers: is hardly fusible before the blowpipe, but in a strong heat becomes black. Specific gravity 3.243: consists of oxyd of uranium and oxygen.

MICACEOUS URANITIC ORE, *U. chalcolithus*.

Hardish, diaphanous, shining internally, of a foliated texture, entirely soluble in nitric acid. Found in Cornwall, near Eibenstock and John-georgenstadt in Saxony, and near Rheinbreidenbach in the electorate of Treves; sometimes on the surface of other ores, sometimes in larger or less particles mixed with rocks of gneiss, garnet, or quartz, most commonly crystallized in cubes, square plates, eight-sided or six-sided prisms. Colour emerald or grass green, often inclining to silvery-white or yellowish, with a greenish-white streak: soluble in nitric acid without effervescence, but insoluble and infusible by alkalies: consists of oxyd of uranium, carbonic acid, and the green kind a little oxyd of copper. Specific gravity 3.12. It is distinguished from mica by its want of elasticity; and by its solubility in nitric acid; and from muriat of copper, for which it has been mistaken, by not communicating a blue and green colour to the flame of a candle.

SULPHURATED URANITE, OR PECHBLENDE, *U. sulphureum*.

Hardish, very ponderous, black, compact, shining internally. It is called *pechblende*, or pitch-blende, from its resemblance to the black variety of sulphuret
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of zink, for which see p. 621. Found at John-georgenstadt in Saxony, either forming entire thin strata alternating with other stratified minerals, or massive and dispersed: colour black, dark grey, or bluish-black, with a darker streak and opaque black powder; texture conchoidal, very brittle: imperfectly soluble in sulphuric and muriatic acids, but perfectly in nitric and nitro-muriatic acids, giving the solution a vinous yellow: forming a grey opaque slag with borax and soda, and a green glass with microcosmic salt. Specific gravity 6.378 to 7.5: contains uranite 86.5, sulphuret of lead 60, silex 5, oxyd of iron 2.5.

TITANIUM, TITANITE.

GENERIC characters, Orange-red, very hard, in minute agglutinated grains; not fusible by any known heat, but when exposed hot to the open air forming a blue or purple oxyd: precipitating a white powder when its crystals or red oxyd are fused in four times their weight of potash, and the whole dissolved in water.

The name of this metal is derived from the Titans, or giants of fabulous history. The substance whence it is extracted, is the red schorl, principally found in Hungary; but it has since been found in France, in the province of Brittany; and it also appears to be the same substance with that which Mr. M'Gregor found in an iron ore, from Menackan in Cornwall, and of which he gives an interesting account in Crell's Journal for 1791. The red schorl found in France is in some specimens of a bright red colour, in others darker. It is found at the surface of the soil, in lumps never more than an inch in diameter, which generally appear rubbed or worn on the surface; but some preserve a regular crystalline form. It is very hard, will cut glass, and is difficultly reduced to powder. The pieces which fly off under the

the hammer are very bright, with polished surfaces. This oxyd, melted with smalt, gives to porcelain a pure regular straw-colour. It has been long used at the manufacture of Sevres, to give porcelain a brown colour.

MENACKAN TITANITE, *T. Menackanita.*

In small irregularly-shaped grains, black, easily pulverised, and the powder attracted by the magnet. Found in the valley of Menackan in Cornwall, also in America and New Holland, in small grains resembling gunpowder, of no determinate shape, and often mixed with fine grey sand: it does not detonate with nitre, but melts with two parts of fixed alkali into an olive-coloured mass, from which nitric acid precipitates a white powder; and this powder mixed with diluted sulphuric acid so that the mass be not too liquid, and evaporated to dryness, produces a blue mass: before the blowpipe it does not decrepitate, but with microcosmic salt it acquires a greenish tinge which becomes brown on cooling. Specific gravity 4.427: contains oxyd of iron 46, oxyd of titanium 45, with some flux and manganese.

ISERINE TITANITE, *T. Iserina.*

In small rounded grains, brownish-black, hard, brittle, of a conchoidal texture, not attracted by the magnet. Found in the sand of the river Iser in Bohemia, of an iron-black colour tending to brown, and is hard, heavy, and brittle.

RUTHILE TITANITE, *T. Ruthila.*

Compact, reddish-brown, opaque, of a foliated texture, forming a violet-black glass with microcosmic salt. Found in Hungary, the Pyrenees, the Alps, and in Brittany, generally crystallized in four or six-sided prisms, or acicular. Specific gravity from
4.180

4.180 to 4.246; when pure, it is composed entirely of oxyd of titanium.

A variety called ANATASE is found in Dauphiny, varying in having its crystals in an elongated octahedron whose base is a square, with the summits complete or truncated, and the faces transversely striate: colour steel-grey, verging to black or deep blue: lustre vitreous, generally opaque. Specific gravity 3.857.

NIGRINE TITANITE, *T. nigrina*.

Compact, hard, brittle, with a waxy lustre and foliated texture, imperfectly soluble in muriatic acid, from which it precipitates a clammy yellowish mass with the addition of ammoniac. Found near Passau in Bavaria, at Arendal in Norway, and near St. Gothard, sometimes massive or disseminated, sometimes crystallized in short obtusangled four-sided prisms: colour reddish, yellowish, or blackish brown, rarely whitish-grey, with a whitish-grey powder. Before the blowpipe it is infusible, but in charcoal it is converted into a black opaque porous slag. Specific gravity 3.5: contains oxyd of titanium 33, silica 35, lime 33.

CHROMIUM, CHROME.

GENERIC characters, White with a shade of yellow, very brittle; very difficult of fusion: gradually oxydating in the nitric acid, and the oxyd becoming green when heated in a close vessel.

This metal, the name of which has been derived from the Greek word *χρῶμα*, colour, has been so called in consequence of the colour which it communicates to some of those substances into the composition of which it enters. The emerald for instance owes its peculiar green colour to the presence of this metal in the state of an oxyd. The spinell-ruby derives its colour from the same metal in the state of an acid.

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We are indebted to Vauquelin for the discovery of this metal. Its uses are not yet known; hereafter perhaps it may afford beautiful and durable colours to the painter and enameller.

CHROMAT OF LEAD, OR RED-LEAD ORE OF SIBERIA, *Chromium plumbi*.

Red with a shade of yellow, and a fine orange-yellow streak and powder; texture compact, crystallized in four-sided prisms; a conductor of the electric fluid. This is the substance in which the metal was first discovered. Chromat of lead was originally met with in a mine situated on the eastern ridge of the Ural mountains, in Siberia, in about the fifty-third degree of north latitude. It occurred, in distinct crystals, in a vein running in gneiss or micaceous schistus: the principal vein of the mine was worked for the sake of the gold it afforded, which is contained in a liver-coloured iron ore of a cubic form. Since that time it has been discovered, in the same neighbourhood, in the form of a thin irregular incrustation, on a kind of ochry micaceous schistus; and also, in a crystalline form, in the interstices of a stratified sand-stone. In Russia it is much used in oil-painting, and is very highly valued on account of its durability. Chromat of lead is distinguished from realgar, which often closely resembles it in colour, by not emitting a smell of garlic upon the application of the blowpipe: from red silver, by the yellow tinge of its powder: from cinnabar, or sulphuret of quicksilver, by the same mark; besides which, cinnabar is entirely volatilized by the action of the blowpipe, whereas chromat of lead is reduced to a metallic state. Chromat of lead is sometimes superficially covered with a pulverulent or minutely-crystallized substance, of a green colour. This is a combination of oxyd of lead with oxyd of chrome; and may by the eye be mistaken for phosphat of lead, or green

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carbonat of copper: but, if thrown into nitric acid, it communicates to the liquid an orange red colour; and may thus be distinguished from both those substances. Specific gravity 6; contains oxyd of lead 65.12, chromic acid 34.88.

CHROMAT of IRON, *Chr. ferri*.

Brown, with an ashy-grey powder and slight metallic lustre; melted with potash, and dissolved in water, imparting an orange-yellow colour to the solution. Found near Gassin in France, and in Siberia, in irregular masses: colour resembling that of brown blende: hardness sufficient to scratch glass: insoluble in nitric acid, but melts with borax into a fine green glass. Specific gravity 4: contains chromic acid 43, oxyd of iron 34.7, alumine 20.3, filix 2.

COLUMBIUM, COLUMBITE.

GENERIC characters, Brownish-black, internally iron-grey, with a chocolate-brown streak and powder; hardish, very brittle, of an imperfectly-foliated texture, opaque, not attracted by the magnet: specific gravity 5.9.

COLUMBITE, *C. compactum*.

Sent to Sir Hans Sloane from Massachusetts, and is at present in the British Museum. Colour dark grey-brown with a glassy lustre: rather hard, and very brittle: longitudinal fracture imperfectly lamellar, cross-fracture fine-grained: when exposed to a violent heat for a long time, was found in a state of black powder. Contains oxyd of columbium 78, oxyd of iron 21.

TANTALIUM, TANTALITE.

GENERIC characters, Blackish-grey, softish, of a granular fracture, not magnetic; specific gravity 6.5:

6.5: not soluble in any acid, nor altering its colour when heated to redness; melting with phosphat of soda and borax into a colourless glass.

TANTALITE, *T. magnesiatum*.

Consisting of oxyd of tantalium combined with the oxyds of iron and manganese. Found at Kimito in Finland, in irregular crystals: colour between bluish-grey and blackish-grey: surface smooth with metallic lustre: very hard; fracture compact. Specific gravity 7.953.

YTTRIO-TANTALITE, *T. yttriatum*.

Consisting of oxyd of tantalium combined with the oxyds of iron and yttria. Found at Kimito in Finland, in small kidney-form masses of inconsiderable hardness: fracture granular, iron-grey, of metallic lustre: may be scratched with a knife, and gives a grey powder. Specific gravity 5.13.

POTASSIUM AND SODIUM.

THESE are the names of two new metals discovered by the decomposition of potash and soda. This grand discovery of the decomposition of alkalies was made by Mr. Davy, and explained by him in his Lectures at the Royal Institution in June 1808.

Potash and soda, in their dry state, are non-conductors, but, when moistened, have the property of conducting electricity. In both instances Mr. Davy clearly produced metalline substances, by bringing them within the action of the Voltaic battery. Oxygen was given out at the positive side of the battery, and at the negative little globules of the metallic base were instantly formed. The metalline bases of the alkalies he named *Potassium* and *Sodium*, chusing the termination *um*, in compliance with the present nomenclature of metals, in order that they might agree with *Platinum*, *Plumbum*, &c. &c. These new metals,

tals, to appearance, are precisely like mercury, but very different from that metal in their various properties. He showed the great inflammability of the new metals, by touching them with the smallest quantity of water, when they instantly took fire. They are both malleable at the common temperature, and may be spread into very thin leaves on a plate of glass, by mere pressure. So great, however, is their attraction for the oxygen of the atmosphere, that they almost instantly became tarnished. Before the discovery of these new metals, only two bodies of this class, viz. iron and platinum, were capable of being welded, and that at a very great heat, whereas separate parts of the potassium and sodium can be united readily at the common temperature of the atmosphere. The specific gravity of these metals is their most singular property, being lighter than water: the specific gravity of potassium, is to that of water as about six to ten; of sodium, as nine to ten. Mr. Davy showed, that the metals which he had spread on glass were easily fusible again by the heat of a spirit-lamp, by the application of which they almost instantly ran into globules. The attraction of these new metals for oxygen was shown by their burning at a red heat, when the alkalies were again revived. In analyzing them with great accuracy, he found the potash contained 14 parts of oxygen, and 86 of metalline base, but the soda contained 20 parts of oxygen to 80 of base.

These metals, introduced into a jar of oxymuriatic gas, spontaneously took fire, and the white fume collected on the glass was in the one case muriat of potash, in the other muriat of soda, or common culinary salt. Particles of the new metals put into water decomposed the water, and gave out a brilliant light. The water used was pure distilled water, which, instantly after the decomposition of the metals, showed, by means of turmeric-paper, that it was become highly alkaline.

alkaline. The same sort of action was exhibited by the nitric acid; and the potassium acted also on the sulphuric and other strong acids. Mr. Davy placed small particles of the metals on ice; and they immediately decomposed the water, and gave out a bright light: alkali was likewise formed on the ice. These metals unite with mercury, and form solids: thus, one part of sodium and three of mercury being mixed, the two fluids united in a state of solidity.

Mr. Davy's brilliant discovery was no sooner known at Paris, than the French chemists eagerly hastened to explore the new track. The researches of Messieurs Thenard and Gay-Lussac (communicated to the National Institute, and published in the *Mem. de la Soc. d'Arcueil* in 1809) appear to have been conducted with uncommon ingenuity and success. By fusing with intense heat, in a clean gun-barrel, the caustic potash in contact with iron filings, and condensing the sublimate by the application of excessive cold at the other extremity of the barrel, they procured a quantity of the fluid metal at a much less expence, and in far greater quantity, than can be obtained by the ordinary Galvanic process; and thus they were enabled to examine the combinations of this new substance on a pretty large scale. The metal of soda was procured in a similar manner. And it was discovered, that the action of these metals, among other striking effects, occasions the decomposition of ammoniac and of the acid of borax.

Some very singular reflections arise from the experiments of these gentlemen. They seem to have established, most convincingly, that the new metals are not simple substances, but really compounds of the several bases with hydrogen. We have not space to enter into their arguments and proofs; but we cannot refrain from adducing a consideration founded on analogy, for which we are indebted to the Edinburgh reviewer: "Every compound must have

have the intermediate density of its distinct ingredients—but the specific gravity of these alkaline metals, one of which absolutely floats on water, is far less than that of the substances from which they are derived. Does not this clearly indicate the union of their bases with some attenuated species of matter, such as hydrogen, which by its infusion may widely distend the primary molecules, and thus reduce the compound to a much lower density.”—And the same judicious writer goes on to add, “Should these metalloids be of the same nature with the ordinary metals, we can only conclude, that all metals are in like manner the compounds of certain bases with hydrogen. These bases may not yet have been exhibited, though we are familiarly acquainted with their oxyds and metalline hydrats, which would be considered as only opposite compounds.” And he concludes, “Such indeed is the present loose and unsettled state of chemical principles, that we should not feel great surprise at seeing the old doctrine of phlogiston, with some modifications, again restored to its former credit.” Edin. Review, for Jan. 1810.

CLASS V. PETRIFICATIONS.

IF water impregnated with calcareous matter remains long in contact with extraneous substances, an earthy incrustation takes place, that soon excludes the incrustated substance from view; which thus, in common language, is said to be *petrified*: the shape, that is, remaining the same; but the substance in appearance converted into stone. In this manner are formed the well-known petrifications of birds'-nests, moss, leaves, &c. If the process be carried on for a sufficient length of time, and the incrustated body be of a perishable nature, as in the case of vegetable matter, the whole of this is removed by gradual decay, and the remaining mass is entirely earthy: but
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its form, and the circumstances of its situation, will generally serve to show its origin.

We beg the reader to bear in mind the distinction between Stalactites and Petrifications given in p. 355.

The warm springs of St. Philippe in Tuscany contain a great proportion of calcareous matter, which they deposit so compactly round substances immersed in them as to be employed for the purpose of obtaining casts, models, &c. With this view, hollow moulds being suspended in the water, the earthy particles are deposited in them; and the deposition, when removed from the mould, preserves the exact impression of it. - These incrustations are very delicately but very firmly compacted; and of a whiteness equal to that of Carara marble. It is said that there are springs of the same kind near Guanacavelica in Peru; and that many vases and statues, &c. are placed in the church of Lima, which have been formed from such depositions. In a similar manner (as Kircher relates in his *Mundus Subterraneus*), the inhabitants of the neighbourhood of Tolfa incrust wooden models of crucifixes and candlesticks with crystals of alum, by keeping them immersed for some time in a solution of that salt; and with these they adorn their altars.

The substance called by the earlier mineralogical writers *osteocolla*, from its resemblance to a mass of agglutinated bones, is nothing more than a calcareous deposition that has taken place round small branches and twigs of trees. In many instances the vegetable substance has been removed, and its place supplied by the deposition of fresh earthy matter: seldom however entirely; for in making a transverse section of any of the branches of such a mass, there may be generally observed the trace of a longitudinal cylindrical cavity; which shows that the deposition originally took place on something that has been subsequently removed.

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The incipient stage of the process just described may be seen in some of the springs of Shotover hill, near Oxford: and in many of the small brooks which run into the Cherwell on the north side of that city. The dead leaves, &c. found in the bottom of these brooks being generally covered with a thin earthy incrustation, which readily peels off.

It is evident that every animal and vegetable substance is liable to be in the situation of becoming a petrification; to enumerate, therefore, the species that have been discovered in that state, and described by various authors, would be after all but giving an imperfect history. The classification, at p. 335, will readily show to what genus any curiosity of this kind, known or hereafter discovered, is to be referred.

SPECIFIC GRAVITIES of MINERALS.

SPECIFIC gravity is the relative, comparative, or apparent, gravity, of any body, in respect of that of an equal bulk or magnitude of another body; denoting that gravity, or *weight*, which is peculiar to each species or kind of body, and by which it is distinguished from all other kinds. The specific gravity of solids is determined by weighing them first in the air, and then in water. A body is said to be specifically heavier than another, when under the same bulk it contains a greater weight than that other; and reciprocally the latter is said to be specifically lighter than the former. While enumerating the different species of minerals, we have given the specific gravities of many of them; but we think it will be gratifying to the reader to see them in a collected form. The following arrangement will therefore show the specific gravities of minerals and other bodies to rain or distilled water, the water being supposed 1000; and the same numbers moreover express nearly the absolute weight of a cubic foot of each in avoirdupoise ounces.

Pure

Pure gold cast	-	-	-	-	19258
Ditto hammered	-	-	-	-	19362
Standard gold cast	-	-	-	-	17486
Ditto hammered	-	-	-	-	17589
Pure silver cast	-	-	-	-	10474
Ditto hammered	-	-	-	-	10511
Standard silver in coin	-	-	-	-	10391
Crude platina in grains	-	-	-	-	15602
Platina purified and fused	-	-	-	-	19500
The same hammered	-	-	-	-	20377
The same drawn into wire	-	-	-	-	21042
The same laminated	-	-	-	-	22069
Mercury	-	-	-	-	13568
Lead fused	-	-	-	-	11352
Copper fused	-	-	-	-	7788
Ditto drawn into wire	-	-	-	-	8878
Brass cast	-	-	-	-	8396
Brass in wire	-	-	-	-	8544
Iron cast	-	-	-	-	7207
Ditto in bar	-	-	-	-	7788
Steel soft, and not hammered	-	-	-	-	7840
Steel hardened	-	-	-	-	7816
Tin, English, fused	-	-	-	-	7291
Ditto hammered	-	-	-	-	7299
Malacca tin fused	-	-	-	-	7296
The same hammered	-	-	-	-	7306
Bismuth	-	-	-	-	9823
Nickel	-	-	-	-	8660
Arsenic, the regulus	-	-	-	-	5763
Cobalt	-	-	-	-	7812
Zink	-	-	-	-	7191
Antimony	-	-	-	-	6702
Manganese	-	-	-	-	6850
Wolfram	-	-	-	-	17600
Diamond	-	-	-	-	3251
Ruby	-	-	-	-	4283
Ruby spinell	-	-	-	-	3760

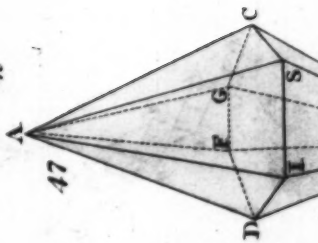
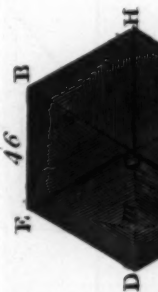
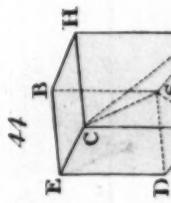
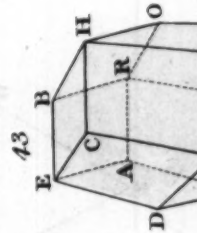
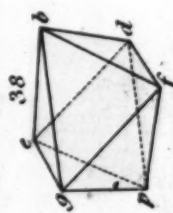
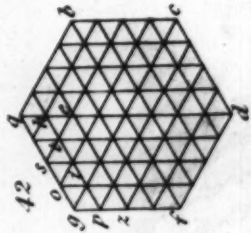
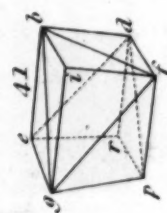
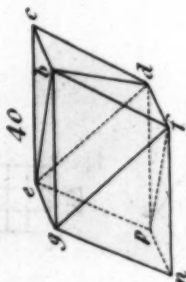
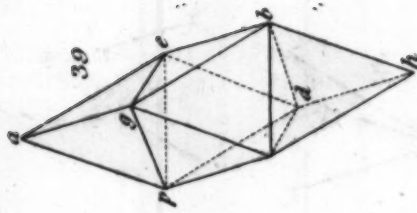
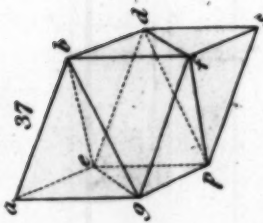
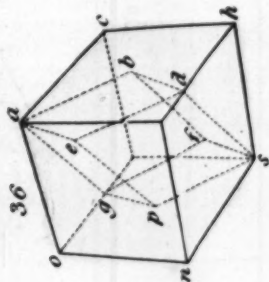
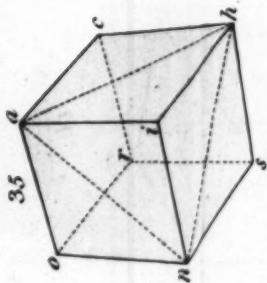
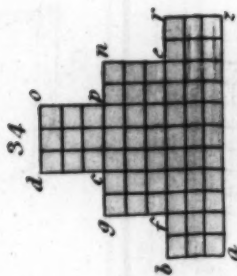
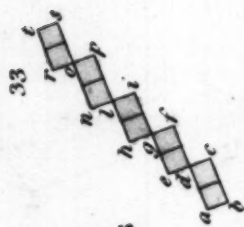
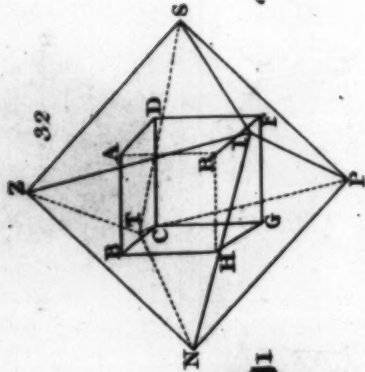
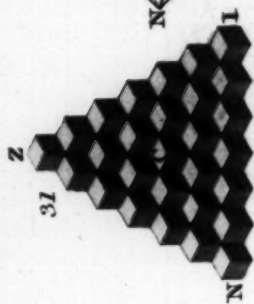
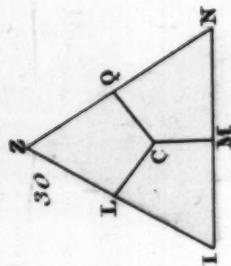
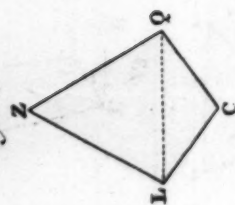
Topaz, oriental	-	-	-	4011
Ditto Brasilian	-	-	-	3536
Ditto Saxon	-	-	-	3564
Sapphire, oriental	-	-	-	3994
Emerald	-	-	-	2775
Adamantine spar	-	-	-	4180
Rock crystal from Madagascar	-	-	-	2653
Quartz	-	-	-	2654
Agate	-	-	-	2590
Onyx	-	-	-	2376
Muscovy talc	-	-	-	2792
Common slate	-	-	-	2672
Calcareous spar	-	-	-	2715
Alabaster	-	-	-	2730
White marble	-	-	-	2716
Limestones, from	-	-	-	1386
Ditto to	-	-	-	2390
Ponderous spar	-	-	-	4474
Fluor spar	-	-	-	3180
Pumice-stone	-	-	-	914
Green glass	-	-	-	2620
English crown-glass	-	-	-	2520
White flint-glass, English	-	-	-	3290
Another piece	-	-	-	3216
White flint lenses	-	-	-	3437
White glass, French	-	-	-	2892
Glass of S. Gobin	-	-	-	2488
Brimstone	-	-	-	1990
Phosphorus	-	-	-	1714
Yellow amber	-	-	-	1078
Distilled or rain water	-	-	-	1000
Sea water	-	-	-	1026
Common spirit of wine	-	-	-	827
Alcohol	-	-	-	820
Vitriolic ether	-	-	-	739
Nitrous	-	-	-	909
Marine	-	-	-	730

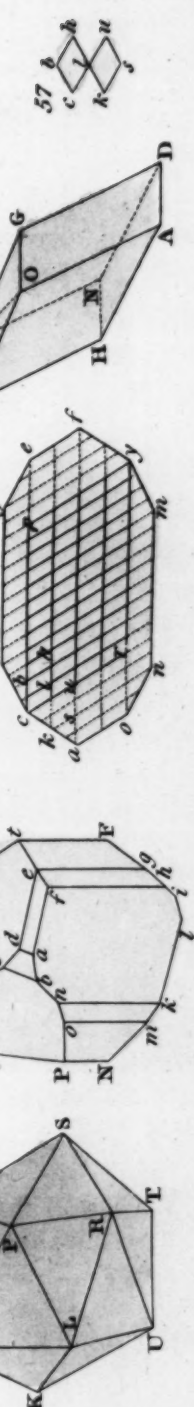
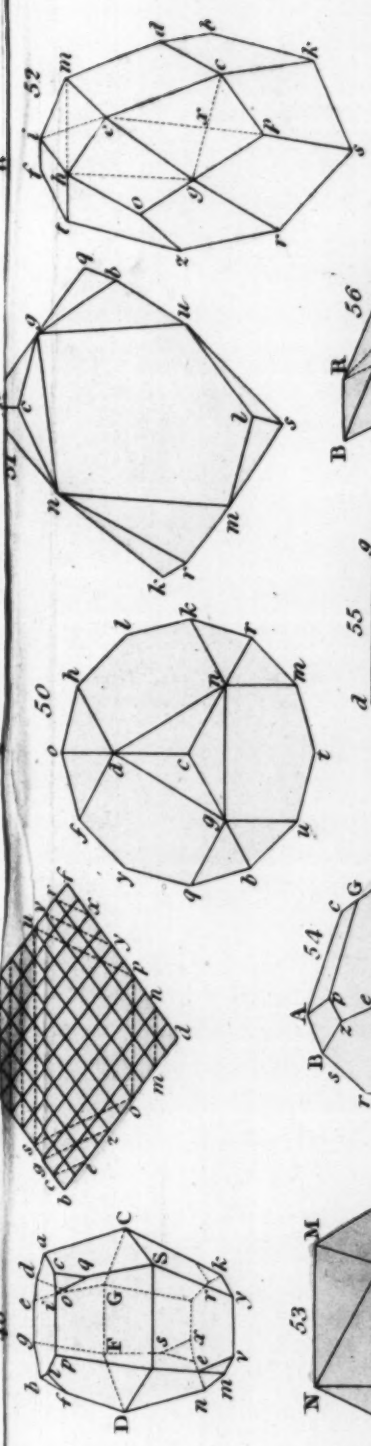
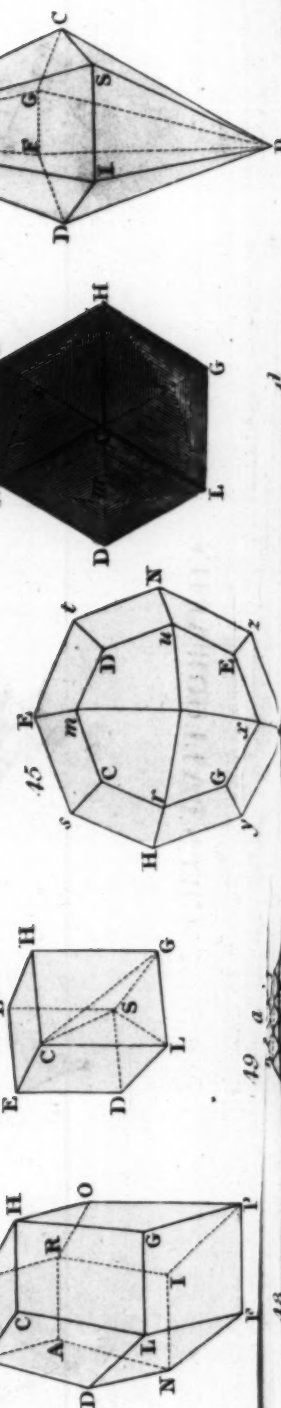
Acetous

CRYSTALLOGRAPHY.

Plate II.

Fig. 29.





Theory of Crystallization.

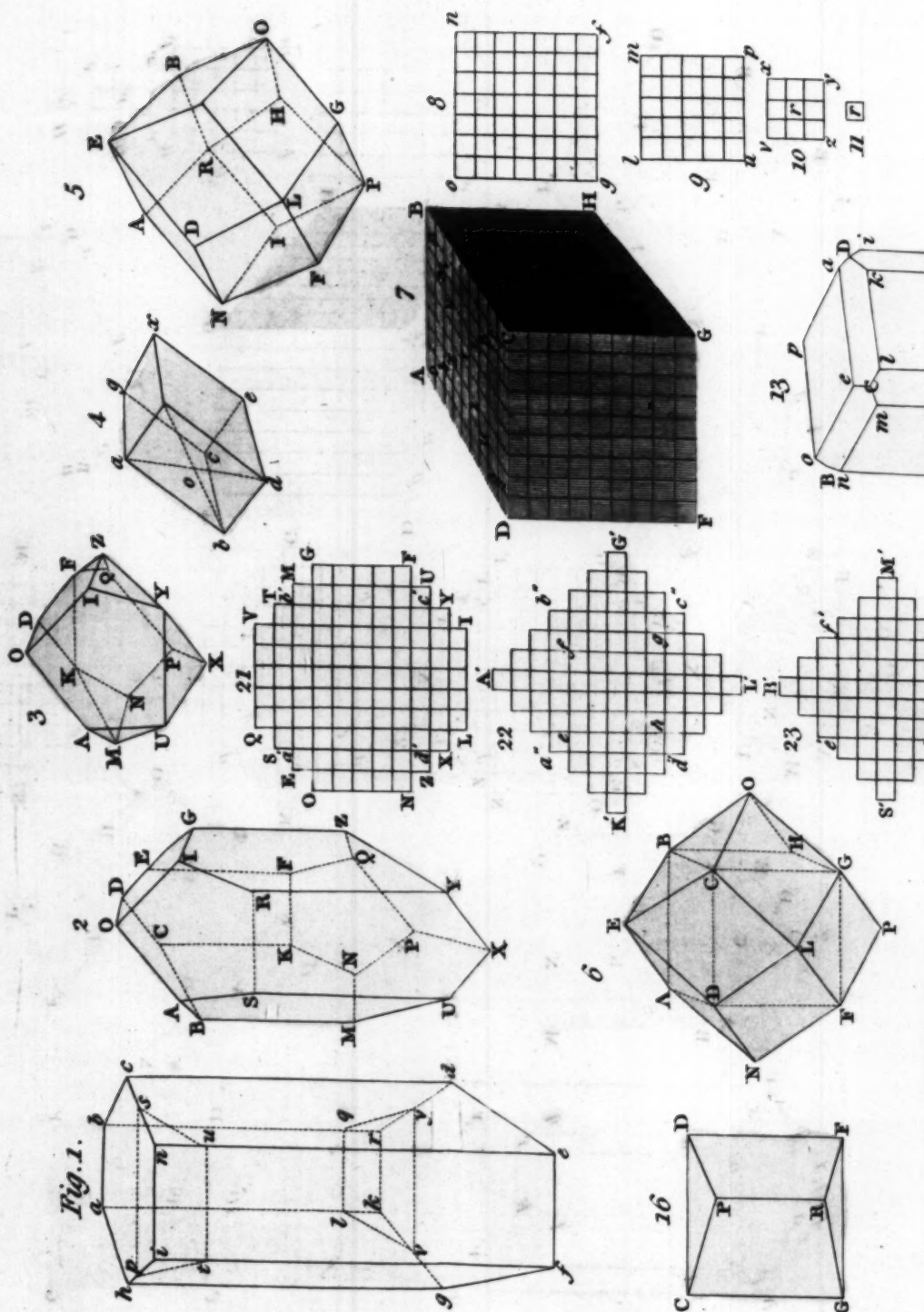
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CRYSTALLOGRAPHY.

Plate I.



OF MINERALS.	METALS.	667
Acetous ether	- - -	866
Concentrated vitriolic acid	-	2125
Ditto nitrous acid	- - -	1580
Ditto marine acid	- - -	1194
Fluor acid	- - -	1500
Oil of olives	- - -	915
Ditto of sweet almonds	- - -	917
Linseed oil	- - -	940
Naptha	- - -	708
Gum elastic	- - -	393
Camphor	- - -	989
Yellow wax	- - -	965
White ditto	- - -	969
Spermaceti	- - -	943
Tallow	- - -	942
Heart of Oak	- - -	1170
Cork	- - -	240
Potassium (new metal)	- - -	600
Sodium (new metal)	- - -	900

Of the CRYSTALLINE FORMS of MINERALS.

MR. HAUY has shown that every particular species of crystals has a primitive figure, and that the variations are owing to the different ways in which the integrant particles arrange themselves. Thus we see that CRYSTALLOGRAPHY is a component part of Mineralogy. See p. 322—325.

Happening to take up an hexangular prism of calcareous spar, or carbonat of lime, *Spatum bracteatum*, (p. 352,) which had been detached from a group of the same kind of crystals, he observed that a small portion of the crystal was wanting, and that the fracture presented a very smooth surface. Let *abcdesgh*, in the Crystallography Plate I. fig. 1, be the crystal; the fracture lay obliquely as the trapezium *psut*, and made an angle of 135° , both with the remainder of the base *abcsph* and with *tuef*, the remainder of the

side *inef*. Observing that the segment *psutin* thus cut off had for its vertex *in*, one of the edges of the base *abcnih* of the prism, he attempted to detach a similar segment in the part to which the next edge *cn* belonged, employed for that purpose the blade of a knife, directed in the same degree of obliquity as the trapezium *psut*, and assisted by the strokes of a hammer. He could not succeed: but, upon making the attempt upon the next edge *bc*, he detached another segment, precisely similar to the first, and which had for its vertex the edge *bc*. He could produce no effect on the next edge *ab*; but from the next following, *ah*, he cut a segment similar to the other two. The sixth edge likewise proved refractory. He then went to the other base of the prism *defghr*, and found, that the edges which admitted sections similar to the preceding ones were not the edges *ef*, *dr*, *gk*, corresponding with those which had been found divisible at the opposite base, but the intermediate edges *dc*, *kr*, *gf*. The trapezium *lgyv* represents the section of the segment, which had *kr* for its vertex. This section was evidently parallel to the section *psut*; and the other four sections were also parallel two and two. These sections were, without doubt, the natural joinings of the layers of the crystal. And he easily succeeded in making others parallel to them, without its being possible for him to divide the crystal in any other direction. In this manner he detached layer after layer, approaching always nearer and nearer the axis of the prism, till at last the bases disappeared altogether, and the prism was converted into a solid, OX, fig. 2, terminated by twelve pentagons, parallel two and two; of which those at the extremities, that is to say, ASRIO, IGEDO, BAODC, at one end, and FKNPQ, MNPXU, ZQPXY, at the other, were the results of mechanical division, and had their common vertices O, P, situated at the centre of the bases of the original prism.

prism. The six lateral pentagons R S U X Y, Z Y R I G, &c. were the remains of the six sides of the original prism.

By continuing sections parallel to the former ones, the lateral pentagons diminished in length; and at the points R, G, coinciding with the points Y, Z, the points S, R, with the points U, Y, &c. there remained nothing of the lateral pentagons but the triangles Y I Z, U X Y, &c. fig. 3. By continuing the same sections, these triangles at last disappeared, and the prism was converted into the rhomboid *ae*, fig. 4. So unexpected a result induced him to make the same attempt upon more of these crystals; and he found that all of them could be reduced to similar rhomboids. He found also, that the crystals of other substances could be reduced in the same manner to certain primitive forms; always the same in the same substances, but every substance having its own peculiar form. The primitive form of fluat of lime, for instance, was an octahedron; of sulphat of barytes, a prism with rhomboidal bases; of field-spath, an oblique-angled parallelopiped, but not rhomboidal; of adamantine spar, a rhomboid, somewhat acute; of blende, a dodecahedron, with rhomboidal sides; and so on. These must therefore be considered as the real *primitive forms* of the crystals; and the other forms which they often assume may be called *secondary forms*.

The primitive crystals obtained by the above process may be divided by sections parallel to their different sides: all the matter which surrounded this primitive crystal may also be divided by sections parallel to the sides of the primitive crystal. It follows from this, that the parts detached by means of these sections are similar, and differ from one another only in size, which diminishes in proportion to the length that the division is carried. But the division of the crystals into similar solids has a term, beyond which

we should come to the smallest particles of the body, which could not be divided without chemical decomposition. It is probable, therefore, that the form of the integrant particles of a body is the same with the primitive form of its crystals. Here, then, we have a method of discovering the form of the particles of bodies; and if this method could be applied to all substances whatever, it would enable us to ascertain the affinity of all bodies for each other by accurate calculation. If the crystals obtained by the above process be the primitive forms, it becomes a question of some consequence to determine in what manner the secondary forms are produced.

According to Haüy, all the parts superadded to the primitive crystal, in order to form the secondary crystal, consist of plates, which decrease regularly by the subtraction of one or more rows of integrant particles, in such a manner, that the number of these ranks, and consequently the form of the secondary crystal, may be determined by theory. To explain this, let us suppose that E P, fig. 5, represents a dodecahedron, terminated by equal and similar rhombs; that this dodecahedron is a secondary crystal, the primitive form of which is a cube: the situation of this cube in the dodecahedron may be conceived from fig. 6. The smaller diagonals D C, C G, G F, F D, of four sides of the dodecahedron, united round the same solid angle L, form the square C D F G. Now there are six solid angles, composed of four planes, to wit, the angles L, O, E, N, R, P, fig. 5; and consequently, by making sections through the smaller diagonals of the sides that form these angles, six squares will be made apparent, which are the six sides of the primitive cube, three of which are represented in fig. 6, C D F G, A B C D, B C G H.

This cube being composed of cubic integrant particles, each of the pyramids, L C D F G for instance, fig. 6, which repose upon its sides, must also, according

ing to the theory, be composed of similar cubic particles. To make this appear, let us suppose that $ABFG$, fig. 7, is a cube composed of 729 small cubes: each of its sides will consist of 81 squares, being the external sides of as many cubic particles, which together constitute the cube. Upon $ABCD$, one of the sides of this cube, let us apply a square lamina, composed of cubes equal to those of which the primitive crystal consists, but which has on each side a row of cubes less than the outermost layer of the primitive cube. It will of course be composed of 49 cubes, 7 on each side; so that its lower base $onfg$, fig. 8, will fall exactly on the square marked with the same letters in fig. 7. Above this lamina let us apply a second $lmpu$, fig. 9, composed of 25 cubes; it will be situated exactly above the square marked with the same letters in fig. 7. Upon this second let us apply a third lamina $vxyz$, fig. 10, consisting only of nine cubes; so that its base shall rest upon the letters $vxyz$, fig. 7. Lastly, on the middle square r let us place the small cube r , fig. 11, which will represent the last lamina. It is evident, that by this process a quadrangular pyramid has been formed upon the face $ABCD$, fig. 7, the base of which is this face, and the vertex the cube r , fig. 11. By continuing the same operation on the other five sides of the cube, as many similar pyramids will in the same manner be formed; which will envelope the cube on every side.

It is evident, however, that the sides of these pyramids will not form continued planes, but that, owing to the gradual diminution of the laminæ of the cubes which compose them, these sides will resemble the steps of a stair. We can suppose, however, (what must certainly be the case,) that the cubes of which the nucleus is formed are exceedingly small, almost imperceptible; that therefore a vast number of laminæ are required to form the pyramids, and consequently

quently that the channels which they form are imperceptible. Now DCBE, fig. 12, being the pyramid resting upon the face ABCD in fig. 7; and CBOG, fig. 12, the pyramid applied to the next face BCGH, fig. 7, if we consider that every thing is uniform from E to O, fig. 12, in the manner in which the edges of the *laminæ of superposition* (as Haüy calls the laminæ which compose the pyramids) mutually project beyond each other, it will readily be conceived that the face CEB of the first pyramid ought to be exactly in the same plane with the face COB of the adjacent pyramid; and that therefore the two faces together will form one rhomb ECOB. But all the sides of the six pyramids amount to 24 triangles similar to CEB; consequently they will form 12 rhombs, and the figure of the whole crystal will be a dodecahedron, similar to that represented in fig. 5 and 6.

The cube, before it arrives at the form of the dodecahedron, passes through a multitude of intermediate modifications, one of which is represented at fig. 13. It may be there seen that the squares *paco*, *klqu*, *mnts*, &c. correspond to the squares ABCD, DCGF, CBHG, &c. in fig. 6, and form the superior bases of as many pyramids, incomplete for want of the laminæ by which they ought to be terminated. The rhombuses EDLC, ECOB, &c. fig. 5, by a necessary consequence are reduced to simple hexagons *acClkD*, *eoBnmC*, &c. fig. 13, and the surface of the secondary crystal is composed of twelve of those hexagons and six squares. This is the case with the boracic spar, allowance being made for some facets which take the place of the solid angles, as will be seen hereafter.

If the decrease of the laminæ of superposition took place according to a more rapid law; if each laminæ had on its circumference two, three, or four, rows of cubes less than the inferior lamina; in that case the pyramids produced being lower, their adjacent faces
would

would no longer form one plane; and therefore the surface of the secondary crystal would consist of twenty-four isosceles triangles, all inclined towards each other.

In this manner Mr. Haüy has shown, that a variety of secondary crystals are formed, and that their forms vary by means of slight variations in the ratio of the *decrement*. To understand this, we must again conceive a cubic nucleus, the different edges of which are so many lines of departure to the same number of decrements, taking place at the same time in two different ways, that is to say, by the subtraction of two ranges parallel to the edges AB, CD, fig. 7, and of one range parallel to the edges AD, BC. Let us suppose also, that each lamina, being in thickness equal only to a small cube of the side AB and CD, is equal to double the side of AD and BC. This disposition, in regard to the decrements proceeding from the lines DC, BC, fig. 7, is represented by fig. 14. In this hypothesis it is evident that, on account of the more rapid decrease in departing from DC or AB, than in departing from BC or AD, the faces produced in the former case will be more inclined to the plane ABCD, while the faces produced in the latter will remain as it were behind; so that the pyramid will no longer be terminated by a single cube E, fig. 12, which, on account of its extreme minuteness, appears to be only a point, but by the range of cubes MNST, fig. 14, which, supposing these cubes to be almost infinitely small, will present the appearance of a simple ridge. By a necessary consequence the pyramid will have for faces two trapeziums, such as DMNC, resulting from the first decrement; and two isosceles triangles, such as CNB, which will be produced by the second decrement. Here the face which corresponds to ABCD, fig. 7, has twenty-five squares on each side, as may be seen in fig. 14, and the structure of the pyramid in question may be imitated artificially by observing the

order and number of the cubes represented in the same figure.

Let us suppose, moreover, that, in regard to the laminæ of superposition which arise on the face BCGH, fig. 7, the decrements follow the same laws, but by cross directions; so that the more rapid of the two may take place in proceeding from BC or GH towards the summit of the pyramid, and the slower in proceeding from CG or BH towards the same summit. The pyramid resulting from these decrements will be placed in a direction opposite to that resting on ABCD, and will have the position exhibited in fig. 17, where it is seen that the edge KL, which terminates the pyramid, instead of being parallel to CD like the edge MN, fig. 14 and 15, is, on the contrary, parallel to BC. We shall then conceive what ought to be done in order that the pyramid which will rest on DCGF, fig. 7, may be turned as represented in fig. 16, and may have its terminating edge PR parallel to CG, fig. 7. We need not notice the pyramids that will rest on the three other faces of the cube, because it is evident that each of these pyramids ought to stand like that which arises on the opposite face.

The sides of all the six pyramids thus formed amount to twelve trapeziums and twelve triangles. Every triangle is evidently contiguous and in the same plane with a trapezium of the nearest pyramid; consequently the secondary crystal thus formed consists of twelve sides, each of which is a pentagon. Several other examples have been given by Mr. Haüy; but these are sufficient to show in what manner the various secondary forms of crystals are constructed, according to the theory of that ingenious philosopher.

In his researches on this subject, Mr. Haüy perceived, that some crystals assumed secondary forms which could not be accounted for by any decrement
whatever

whatever along the edges. Thus, for instance, some bodies, the primary form of which is cubic, are sometimes found crystallized in regular octagons. Mr. Haüy explains the formation of these secondary crystals, by supposing that the decrement took place parallel, not to the edges, but to the diagonals of the faces of the primary cubes. In order to comprehend this, let us suppose $ABCD$, fig. 18, to be the surface of the lamina composed of small cubes, the bases of which are represented by the little squares in the figure. It is evident, that the cubes $a, b, c, d, e, f, g, h, i$, are in the direction of the diagonal of the square $ABCD$; that the row of cubes q, v, k, u, x, y, z , is parallel to the diagonal; as also the row n, t, l, m, p, o, r, s ; and that the whole figure might be divided into rows of squares, each of which would be parallel either to the diagonal AC or DB . Now we may conceive that the laminæ of superposition, instead of decreasing by rows of cubes parallel to the edges AB, AD , decrease by rows parallel to the diagonals.

Let it be proposed to construct around the cube $ABGF$, fig. 19, considered as a nucleus, a secondary solid, in which the laminæ of superposition shall decrease on all sides by single rows of cubes, but in a direction parallel to the diagonals. Let $ABCD$, fig. 20, the superior base of the nucleus, be divided into eighty-one squares, representing the faces of the small cubes of which it is composed. Fig. 21, represents the superior surface of the first lamina of superposition; which must be placed above $ABCD$, fig. 20, in such a manner that the points a', b', c', d' , fig. 21, answer to the points a, b, c, d , fig. 20. By this disposition, the squares Aa, Bb, Cc, Dd , fig. 20, which compose the four outermost rows of squares parallel to the diagonals AC, BD , remain uncovered. It is evident also, that the borders QV, ON, IL, GF , fig. 21, project by one range beyond the borders AB, AD, CD, BC , fig. 20, which is necessary, that the

nucleus may be enveloped towards these edges: for, if this were not the case, re-entering angles would be formed towards the parts AB, BC, CD, DA, of the crystal; which angles appear to be excluded by the laws which determine the formation of simple crystals; or, which comes to the same thing, no such angles are ever observed in any crystal. The solid must increase, then, in those parts to which the decrement does not extend. But, as this decrement is alone sufficient to determine the form of the secondary crystal, we may set aside all the other variations which intervene only in a subsidiary manner, except when it is wished, as in the present case, to construct artificially a solid representation of a crystal, and to exhibit all the details which relate to its structure.

The superior face of the second lamina will be A' G' L' K', fig. 22. It must be placed so that the points a'' , b'' , c'' , d'' , correspond to the points a' , b' , c' , d' , fig. 21, which will leave uncovered a second row of cubes at each angle, parallel to the diagonals AC and BD. The solid still increases towards the sides. The large faces of the laminæ of superposition, which in fig. 21 were octagons, in fig. 22 arrive at that of a square; and when they pass that term they decrease on all sides; so that the next lamina has for its superior face the square B' M' L' S', fig. 23, less by one range in every direction than the preceding lamina, fig. 22. This square must be placed so that the points e' , f' , g' , h' , fig. 23, correspond to the points e , f , g , h , fig. 22. Figures 24, 25, 26, and 27, represent the four laminæ which ought to rise successively above the preceding; the manner of placing them being pointed out by corresponding letters, as was done with respect to the three first laminæ. The last lamina z, fig. 28, is a single cube, which ought to be placed upon the square z, fig. 27.

The laminæ of superposition, thus applied upon the side ABCD, fig. 20, evidently produce four faces,
which

which correspond to the points A, B, C, D, and form a pyramid. These faces, having been formed by laminæ, which began by increasing, and afterwards decreased, must be quadrilaterals of the figure represented in fig. 29, in which the inferior angle C is the same point with the angle C of the nucleus, fig. 19 and 20; and the diagonal LQ represents L'G' of the lamina A'G'L'K', fig. 22. And as the number of laminæ composing the triangle LQC, fig. 29, in the Crystallography Plate II. is much smaller than that of the laminæ forming the triangle ZLQ, it is evident that the latter triangle will have a much greater height than the former.

The surface, then, of the secondary crystal thus produced, must evidently consist of twenty-four quadrilaterals, (for pyramids are raised on the other five sides of the primary cube exactly in the same manner,) disposed three and three around each solid angle of the nucleus. But, in consequence of the decrement by one range, the three quadrilaterals which belong to each solid angle, as C, fig. 18, will be in the same plane, and will form an equilateral triangle ZIN, fig. 30. The twenty-four quadrilaterals, then, will produce eight equilateral triangles; one of which is represented at fig. 31, in such a manner as to show, on a simple view, the assortment of the cubes that concur to form it; and the secondary solid will be a regular octahedron. Fig. 32 shows this octahedron in which the cubic nucleus is inclosed, so that each of its solid angles C, D, F, G, &c. corresponds to the centre of one of the triangles IZN, IPN, PFS, SIZ, &c. of the octahedron. It may be readily seen, that, to extract this nucleus, it would be necessary to divide the octahedron in its eight solid angles, by sections parallel to the opposite edges. For example, the section made in the angle Z ought to be parallel to the edges IS, IN, TN, TS, and hence will result a square which will itself be situated
parallel

parallel to the superior base ABCD of the nucleus, and which will be confounded with that base when the sections have made the faces of the octahedron to disappear entirely. This is the structure of the octahedral sulphuret of lead and of muriat of soda. Decrements which take place in this manner have been called by Mr. Haüy *decrements on the angles*.

There are certain crystals in which the decrements on the angles do not take place in lines parallel to the diagonals, but parallel to lines situated between the diagonals and the edges. This is the case when the subtractions are made by ranges of double, triple, &c. molecularæ. Fig. 33 exhibits an instance of the subtractions in question; and it is seen that the molecularæ which compose the range represented by that figure are assorted in such a manner as if of two there were formed only one; so that we need only to conceive the crystal composed of parallelopipedons having their bases equal to the small rectangles *abcd*, *edfg*, *hgil*, &c. to reduce this case under that of the common decrements on the angles. To this particular kind of decrement Mr. Haüy has given the name of *intermediate*.

In other crystals the decrements, either on the edges or on the angles, vary according to laws, the proportion of which cannot be expressed but by the fraction $\frac{2}{3}$ or $\frac{3}{4}$. It may happen, for example, that each lamina exceeds the following by two ranges parallel to the edges, and that it may at the same time have an altitude triple that of a simple molecule. Fig. 34 represents a vertical geometrical section of one of the kinds of pyramids which would result from this decrement; the effect of which may be readily conceived, by considering that AB is a horizontal line taken on the upper base of the nucleus, *bazr* the section of the first lamina of superposition, *gfen* that of the second, &c. These decrements Mr. Haüy has called *mixed*. Both of these last species of decrements

ments occur but rarely; Mr. Haüy found them only in certain metallic substances.

All the metamorphoses to which crystals are subjected depend, according to Mr. Haüy, on the laws of structure just explained, and others of the like kind. Sometimes the decrements take place at the same time on all the edges; as in the dodecahedron having rhombuses for its planes, as before mentioned; or on all the angles, as in the octahedron originating from a cube. Sometimes they take place only on certain edges or certain angles. Sometimes there is an uniformity between them; so that it is one single law by one, two, three, ranges, &c. which acts on the different edges, or the different angles. Sometimes the law varies from one edge to the other, or from one angle to the other; and this happens above all when the nucleus has not a symmetrical form; for example, when it is a parallelopipedon, the faces of which differ by their respective inclinations, or by the measure of their angles. In certain cases the decrements on the edges concur with the decrements on the angles to produce the same crystalline form. It happens also sometimes that the same edge, or the same angle, is subjected to several laws of decrement that succeed each other. In short, there are cases where the secondary crystal has faces parallel to those of the primitive form, and which combine with the faces produced by the decrements to modify the figure of the crystal. The crystals arising from a single law of decrement are called by Mr. Haüy *simple secondary forms*; those which arise from several simultaneous laws of decrement, he calls *compound secondary forms*.

In what has been said respecting the decrements to which the laminæ of superposition are subjected, the only view has been to unfold the laws of structure. It has not been meant to assert that, in the formation of a dodecahedral crystal, or one of any other form having a cube for nucleus, the crystallization has

has originally produced that nucleus, such as is extracted from the dodecahedron, and made it afterwards pass to the figure of that dodecahedron, by the successive application of all the laminæ of superposition by which it is covered. On the contrary, it seems proved, that from the first the crystal is a very small dodecahedron, containing a cubical nucleus proportioned to its small size, and that the crystal afterwards increases by degrees without changing its form, by new layers which envelop it on all sides, so that the nucleus increases also, always preserving the same relation with the whole dodecahedron.

Mr. Haüy found, that the primitive form of all the crystals which he examined may be reduced to six: 1. The parallelopipedon in general, comprehending the cube, the rhomboid, and all solids terminated by six sides, parallel two and two; 2. The regular tetrahedron; 3. The octahedron with triangular sides; 4. The hexagonal prism; 5. The dodecahedron bounded by rhombs; 6. The dodecahedron bounded by isosceles triangles. Were we to suppose that these primitive forms are exactly similar to the form of the integrant particles which compose them, it would follow, that the integrant particles of all the crystals hitherto formed have only six different forms. This supposition, however, is not probable; because the same nucleus has been discovered in different species of minerals, and because we can easily conceive integrant particles of different forms combining in such a manner as to compose nuclei of the same figure, just as we have seen that different primitive forms are capable of producing the same secondary form. Yet there is no crystal from which a nucleus in the form of a parallelopipedon may not be extracted, if we confine ourselves to six sections, parallel two and two. In a multitude of substances this parallelopipedon is the last term of the mechanical division, and consequently the real nucleus. But there are certain minerals where

where this parallelopipedon is divisible, as well as the rest of the crystal, by farther sections made in the different directions of the faces; and there thence necessarily results a new solid, which will be the nucleus, if all the parts of the secondary crystal, superadded to this nucleus, are similarly situated. When the mechanical division conducts to a parallelopipedon, divisible only by sections parallel to its six faces, the molecularæ are parallelopipedons similar to the nucleus; but, in all other cases, their form differs from that of the nucleus.

EXAMPLES of PRIMITIVE FORMS.

Let *ach sno*, fig. 35, be a cube, having two of its solid angles, *a*, *s*, situated on the same vertical line. This line will be the axis of the cube; and the points *a* and *s* will be its summits. Suppose this cube to be divisible by sections, each of which, such as *ahn*, passes through one of the summits *a*, and by two oblique diagonals *ah*, *an*, contiguous to this summit. This section will detach the solid angle *i*; and as there are six solid angles, situated laterally, viz. *i*, *h*, *c*, *r*, *o*, *n*, the six sections will produce an acute rhomboid, the summits of which will be confounded with those of the cube. Fig. 36 represents this rhomboid existing in the cube, in such a manner that its six lateral solid angles, *b*, *d*, *f*, *p*, *g*, *e*, correspond to the middle of the faces *achi*, *crsh*, *hins*, &c. of the cube. But geometry shows that each of the angles, at the summits *bag*, *dsf*, *psf*, &c. of the acute rhomboid, are equal to 60° , from which it follows that the lateral angles *abf*, *agf*, &c. are equal to 120° . Besides, it is proved by theory, that the cube results from a decrement which takes place by a single range of small rhomboids, similar to the acute rhomboid, on the six oblique ridges *ab*, *ag*, *ae*, *sd*, *sf*, *sp*. This decrement produces two faces, one on each side of each of these ridges, which makes in all twelve faces. But

as the two faces, which have the same ridge for their line of departure, are on the same plane by the nature of the decrement, the twelve faces will be reduced to six, which are squares; so that the secondary solid is a cube. This result is analogous to that of the very obtuse calcareous spar before-mentioned.

Let us now suppose that the cube, fig. 35, admits, in regard to its summits *a, s*, two new divisions similar to the preceding six, that is to say, one of which passes through the points *c, i, o*, and the other through the points *h, n, r*. The first will pass also through the points *b, g, e*, and the second through the points *d, f, p*, fig. 36 and 37, of the rhomboid; from which it follows, that these two divisions will detach each a regular tetrahedron *b, a, g, e*, or *d, s, f, p*, fig. 37, so that the rhomboid will be found converted into a regular octahedron *ef*, fig. 38, which will be the real nucleus of the cube; since it is produced by divisions similarly made, in regard to the eight solid angles of the cube. If we suppose the same cube to be divisible, throughout its whole extent, by sections analogous to the preceding, it is clear that each of the small rhomboids of which it is the assemblage, will be found, in like manner, subdivided into an octahedron, with two regular tetrahedra applied on the two opposite faces of the octahedron.

By taking the octahedron for nucleus, we may construct around this nucleus a cube by regular subtractions of small complete rhomboids. For example, if we suppose decrements by a single range of these rhomboids, having *b* for their point of departure, and made in a direction parallel to the inferior edges *gf, eg, de, df*, of the four triangles, which unite to form the solid angle *b*, there will result four faces, which will be found on a level, and, like the octahedron with six solid angles, similar decrements around the other five angles will produce twenty faces, which, taken four and four, will be equally on a level, which

will

will make, in the whole, six distinct faces, situated as those of the cube, fig. 35; so that the result will be precisely the same as in the case of the rhomboid considered as nucleus.

In whatever manner we proceed to subdivide either the cube, the rhombus, or the octahedron, we shall always have solids of two forms, that is to say, octahedra and tetrahedra, without ever being able to reduce the result of the division to unity. But the molecular of a crystal being necessarily similar, it appeared to be probable that the structure was as it were interspersed with a multitude of small vacuities, occupied either by the water of crystallization or by some other substance; so that, if it were possible to carry the division to its limits, one of the two kinds of solids in question would disappear, and the whole crystal would be found composed only of molecular of the other form.

This idea is the more admissible, as each octahedron being enveloped by eight tetrahedra, and each tetrahedron being equally enveloped by four octahedra, whichever of the forms we imagine to be suppressed, the solids that remain will join exactly by their edges; so that, in this respect, there will be continuity and uniformity throughout the whole extent of the mass. The manner in which each octahedron is enveloped by eight tetrahedra may be readily conceived, if we take care that in dividing the cube, fig. 35, only by the six sections given by the rhombus, we may depart at pleasure from any two, a, s ; o, h ; c, n ; i, r ; of the eight solid angles, provided that these two angles be opposite to each other. But if we depart from the angles a, s , the rhomboid will have the position shown at fig. 37. On the other hand, if we depart from the solid angles o, h , these angles will become the summits of a new rhomboid, fig. 39, composed of the same octahedron as that of fig. 38, with two new tetrahedra applied on the faces bdf, egp ,

fig. 39, which were unoccupied on the rhomboid of fig. 37. Fig. 40 and 41 represent, one, the case in which the two tetrahedra repose on the faces dbe , fgp , of the octahedron; the other, that in which they would rest on the faces bfg , dep . It is thence seen, that whatever may be the two solid angles of the cube assumed for the points of departure, we shall always have the same octahedron, with two tetrahedra contiguous by their summits to the two solid angles in question; and, as there are eight of these solid angles, the central octahedron will be circumscribed by eight tetrahedra, which will rest on its faces. The same effect will take place if we continue the division always parallel to the first sections. Each face of the octahedron, then, however small we may suppose that octahedron to be, adheres to a face of the tetrahedron, and reciprocally. Each tetrahedron then is enveloped by four octahedra.

The structure here explained is that of sparry fluor, p. 377. By dividing a cube of this substance we may, at pleasure, extract rhomboids, having the angles formed by their planes equal to 120° or regular octahedra, or tetrahedra, equally regular. There are a small number of other substances, such as rock-crystal, carbonat of lead (sparry lead), &c. which, being mechanically divided beyond the term at which we should have a rhomboid or parallelopipedon, give also parts of various different forms assorted together in a manner even more complex than in sparry fluor. These mixed structures necessarily occasion uncertainty respecting the real figure of the integral molecule which belong to the substances in question. It has, however, been observed, that the tetrahedron is always one of those solids which concur to the formation of small rhomboids or parallelopipedons that would be drawn from the crystal by a first division. On the other hand there are substances, which, being divided in all possible directions, resolve themselves only into tetrahedra.

tetrahedra. Of this number are garnet, blend, and tourmaline.

In short, several minerals are divisible into right triangular prisms. Such as apatite, p. 379, the primitive form of which is a regular right hexahedral prism, divisible parallel to its bases and its planes, from which necessarily result right prisms with three planes, as may be seen by inspecting fig. 43, which represents one of the bases of the hexahedral prism divided into small equilateral triangles, which are the bases of so many molecularæ, and which, being taken two and two, form quadrilateral prisms with rhombuses for their bases. By adopting then the tetrahedron in such doubtful cases, we should reduce, in general, all the forms of integral molecularæ to three, remarkable by their simplicity, viz. the parallelopipedon, the simplest of all the solids which have faces parallel two and two; the triangular prism, the simplest of all prisms; and the tetrahedron, which is the simplest of pyramids. This simplicity may furnish a reason for the preference given to the tetrahedron in sparry fluor, and the other substances here spoken of. But the essential object is, that the different forms to which the mixed structures in question conduct, are assorted in such a manner, that their assemblage is equivalent to a sum of small parallelopipedons, as we have seen to be the case in regard to sparry fluor; and that the laminæ of superposition, applied on the nucleus, decrease by subtractions of one or more ranges of these parallelopipedons; so that the basis of the theory exists independently of the choice which might be made of any of the forms obtained by the mechanical division.

By the help of this result, the decrements to which crystals are subject, whatever be their primitive forms, are found brought back to those which take place in substances where this form, as well as that of the molecularæ, are indivisible parallelopipedons; and
theory

theory has the advantage of being able to generalize its object, by connecting with one fact that multitude of facts which by their diversity seem to be little susceptible of concurring in a common point. What has been here said will be better illustrated by a few examples of the manner in which we may reduce to the theory of the parallelopipedon that of the forms different from that solid.

Crystals, the Molecular of which are Tetrahedra, with Isosceles Triangular Faces.

1. Primitive garnet, fig. 43.—*Geometrical Character.* Respective inclination of any two of the faces of the dodecahedron 120° . Angles of the rhombus $CLGH$, C or $G = 109^\circ 28' 16''$; L or $H = 78^\circ 31' 44''$. See p. 429.

Though garnets of the primitive form be in general vitreous on the fractures, there are perceived on them, however, laminæ situated parallel to the rhombuses which compose their surface. Let us suppose the dodecahedron divided in the direction of its laminæ, and, for the greater simplicity, let us make the sections pass through the centre. One of these sections, viz. that which will be parallel to the two rhombuses $DLFN$, $BHOR$, will concur with a hexagon which would pass through the points E, C, G, P, I, A , by making the tour of the crystal. A second section parallel to the two rhombuses $GLFP$, $BEAR$, will coincide with another hexagon shown by the points D, C, H, O, I, N . If the division be continued parallel to the other eight rhombuses, taken two and two, we shall find that the planes of the sections will be confounded with four new hexagons analogous to the preceding. But by resuming all these hexagons, it is seen that their sides correspond, some of them with the small diagonals of the rhombuses of the dodecahedron, viz. those which would be drawn from C to G , from A to I , from C to B ,
&c.

&c. and others would correspond with the different ridges EC, GP, PI, EA, &c.

The planes then of the sections, passing through the sides and through the small diagonals of the twelve rhombuses, will subdivide the whole surface into twenty-four isosceles triangles, which will be the halves of these rhombuses. And, since the planes of the sections pass also through the centre of the crystal, they will detach twenty-four pyramids with three faces, the bases of which, if we choose, will be the external triangles that make a part of the surface of the dodecahedron, and of which the summits will be united in the centre. Moreover, if we take, for example, the six tetrahedra which have for external faces the halves of the three rhombuses CEDL, CLGH, CEBH, these six tetrahedra will form a rhomboid represented by fig. 44; and in which the three inferior rhombuses DLGS, GHBS, DEBS, result from three divisions which pass, one through the hexagon DLGORA, fig. 43; the second through the hexagon GHBANF; and the third through the hexagon BEDFPO. Fig. 44 represents also the two tetrahedra, the bases of which make part of the rhombus CLGH. One of these is marked by the letters L, C, G, S, and the other by the letters H, C, G, S. By applying what has been said to the other nine rhombuses, which are united three and three around the points F, A, H, fig. 44, we shall have three new new rhomboids; from which it follows, that the twenty-four tetrahedra, considered six and six, form four rhomboids; so that the dodecahedron may be conceived as being itself immediately composed of these four rhomboids, and in the last analysis of twenty-four tetrahedra. The dodecahedron having eight solid angles, each formed by three planes, we might have considered them as being the assemblage of the four rhomboids, which would have for exterior summits the four angles G, B, D, A;
from

from which it results that any one of the faces, such as $CLGO$, is common to two rhomboids, one of which would have its summit in C , and the other in G , and which would themselves have a common part in the interior of the crystal.

It may be farther remarked, that a line GS , fig. 44, drawn from any one, G , fig. 43, of the solid angles composed of three planes, as far as the centre of the dodecahedron, is, at the same time, the axis of the rhomboid, which would have its summit in G , and one of the edges of that which would have its summit in C , fig. 43 and 44. The composing rhomboids then have this property, that their axis is equal to the side of the rhombus. With a little attention it will be easily seen, that in each tetrahedron, such as $CLGS$, fig. 44, all the faces are equal and similar isosceles triangles. If we should continue the division of the dodecahedron by sections passing between those which we have supposed to be directed towards the centre, and which should be parallel to them, we should obtain tetrahedra always smaller, and arranged in such a manner, that, taking them in groupes of six, they would form rhomboids of a bulk proportioned to their own.

The tetrahedra, which would be the term of the division, were it possible for us to reach it, ought to be considered as the real molecularæ of the garnet. But we shall see, that, in the passage to the secondary forms, the laminæ of superposition, which envelop the nucleus, really decrease by ranges of small rhomboids, each of which is the assemblage of six of these tetrahedra. The sulphuret of zink or blend, has the same structure as the garnet. See p. 621.

2. **TRAPEZOIDAL GARNET**, fig. 45.—*Geometrical Character.* Respective inclination of the trapezoids united three and three around the same solid angle D, C, G , &c. $146^{\circ} 26' 33''$; of the trapezoids united four and four around the same solid angle u, x, r , &c.

$131^{\circ} 48' 36''$. Angles of any one of the trapezoids $mDuL$, $L = 78^{\circ} 27' 46''$; $D = 117^{\circ} 2' 8''$; m or $u = 82^{\circ} 15' 3''$. The value of the angle L is the same as that of the acute angle of the nucleus of calcareous spar.

This variety results from a series of laminæ decreasing at the four edges, on all the faces of the primitive dodecahedron. For the more simplicity, let us first consider the effect of this decrement in regard to the rhombus $CLGH$, fig. 43. We have just seen that this rhombus was supposed to belong in common to two rhomboids, which should have for summits, one, the point C , and the other, the point G . Let us suppose that the laminæ applied to this rhombus decrease towards their four edges by subtractions of a single range of small rhomboids, in such a manner that, in regard to the two edges CL , CH , circumstances are the same as if the rhombus belonged to the rhomboid which has its summit in C ; and that, in regard to the other two edges GL , GH , the effect is the same as if the rhombus belonged to the rhomboid having its summit in G . This disposition is admissible here in consequence of the particular structure of the dodecahedron, which permits us to obtain small rhomboids, some of which have their faces parallel to the faces of that with its summit in C , and the rest to that having its summit in G .

The results of the four decrements being thus perfectly similar to each other, the laminæ of superposition, applied to the rhombus $CLGH$, and on each of the other rhombuses of the dodecahedron, will form as many right quadrangular pyramids, which will have for bases these same rhombuses. In fig. 46 may be seen the pyramids which rest on the three rhombuses $CLDE$, $CEBH$, $CGHB$, fig. 43, and which have for summits the points m , e , s , fig. 46; but, on account of the decrement by a simple range, the adjacent triangular faces, such as EmC , EsC , of the two

pyramids that belong to the rhombuses $C L D E$, $C E B H$, are on a level, and form a quadrilateral $E m C s$. But we had twelve pyramids, and consequently forty-eight triangles. Dividing by two, we shall then have twenty-four quadrilaterals, which will compose the surface of the secondary crystal. But, because the rhomboidal bases of the two pyramids extend more, in proceeding from L to E or from H to E , than in proceeding from D to C or from B to C , the sides $m E$, $E s$, of the quadrilateral will be longer than the sides $C m$, $C s$. Moreover, we shall evidently have $m E$ equal to $E s$, and $C m$ equal to $C s$. The quadrilaterals will then be trapezoids, which will have their sides equal to two and two. There seems to be no crystalline form where the striæ, when they exist, point out, in a more sensible manner than in this, the mechanism of the structure. We may here see the series of decreasing rhombuses which form each of the pyramids $C L D E m$, $C E B H s$, &c. fig. 46; and sometimes the furrows are so deep that they produce a kind of stair, the steps of which have a more particular polish and brilliancy than those of their facets, which are parallel to the faces $C E D L$, $C H B E$, &c. of the nucleus.

If the decrements stop abruptly at a certain term, so that the pyramids are not terminated, the twenty-four trapezoids will be reduced to elongated hexagons, which will intercept twelve rhombuses parallel to the faces of the nucleus. This is the variety to which is given the name of *intermediary garnet*. In the sulphuret of zink, the regular octahedron results from a decrement by a range around the eight solid angles, composed of three planes, viz. C , B , O , G , F , D , A , I , fig. 43. The same substance assumes also the figure of a regular tetrahedron, by the help of a decrement by one range on four only of the eight solid angles before-mentioned, such as C , O , F , A . This tetrahedron is remarkable by its structure, which presents

presents an assemblage of other tetrahedra with isosceles faces.

Crystals, the Moleculæ of which are Triangular Prisms.

ORIENTAL.—This appellation is given to a kind of gem known under the names of the *ruby*, *sapphire*, and *oriental topaz*, according as it is red, blue, or yellow. It so rare to find crystals of this gem which do not exhibit marks of a precipitate formation, or which have not been rolled, that hitherto we have had no accurate description of its different varieties, nor any precise indication of the nature of the particular angles of each variety. The crystals from which were drawn the following results, were of a form sufficiently well characterized.

1. *Primitive Oriental*.—It crystallizes in the form of a regular hexahedral prism divisible parallel to its bases. Theory points other joinings, parallel to the planes, from which it follows, that the molecula is an equilateral triangular prism. The height of this prism, such as given by theoretic calculation, is a little less than three times the height of the triangle of the base.

2. *Elongated Oriental*, fig. 47.—*Geometrical Character*. Respective inclinations of the triangles I A S, I B S, $139^{\circ} 54'$. Angles of the triangle I A S, $A = 22^{\circ} 54'$, I or S $= 78^{\circ} 48'$. This form is the effect of a decrement by a simple range of small quadrangular prisms on all the edges of the bases of the nucleus. Let *q d*, fig. 42, be the superior base, subdivided into small triangles, which represent the analogous bases of so many moleculæ. The edges of the laminæ of superposition will correspond successively to the hexagons *hilmnr*, *ekuxyv*, &c. from which it evidently follows, that the subtractions take place by ranges of small parallelipedons or quadrangular prisms, composed each of two triangular prisms.

3. *Minor Oriental*.—*Geometrical Character*. Dodecahedron formed of two right pyramids less elongated than those of the preceding variety. The triangles which correspond to IAS, IBS, are inclined to each other $122^{\circ} 36'$. In each of these triangles the angle of the summit is 31° , and each of the angles at the base is $74^{\circ} 30'$. The law from which this variety results differs from that which produces the preceding, as it determines a mixed decrement by three ranges in breadth and two ranges in height.

4. *Enneagonal Oriental*, fig. 48.—*Geometrical Character*. Inclination of each small triangle, such as *cqi*, to the adjacent base *aci plbg ed*, $122^{\circ} 18'$. It is the elongated oriental, the summits of which are replaced by two faces, parallel to the bases of the nucleus, with the addition of six small isosceles triangles *cqi*, *lbf*, *vzm*, &c. the three superior of which are alternate in position with the three inferior. These triangles result from a decrement by three ranges of small quadrangular prisms on the three angles of the superior base of the nucleus, such as *b, d, g*, fig. 42, and on the intermediate angles of the inferior base. It may be readily conceived, that in the decrement which takes place, for example, on the angle *g*, the three ranges, which remain unoccupied between that angle and the corresponding edge of the first lamina of superposition, are, 1st, the small rhombus *goip*, which alone forms the first range; 2d, the two rhombuses *osti*, *pzdi*; 3d, the three rhombuses situated on the same line behind the two preceding. Crystals of the oriental are found particularly in the kingdom of Pegu.

EXAMPLES OF COMPOUND SECONDARY FORMS.

1. *PRISMATIC CALCAREOUS SPAR*, fig. 1. The bases of this prism are produced in consequence of a decrement by a single range on the angles of the summits *baf*, *gaf*, *bag*, *dex*, *dec*, *cex*, fig. 4, of the
the

the primitive form. The six planes result from a decrement by two ranges on the angles bdf , fxg , bcg , dfx , dbc , cgx , opposite to the preceding. Let $abdf$, fig. 49, be the same face of the nucleus as fig. 4. The decreasing edges situated towards the angle of the summit a will successively correspond with the lines hi , kl , &c. and those which look towards the inferior angle d will have the positions pointed out by mn , op , &c. But in consequence of the first decrement taking place by one range, we prove that the face which results from it is perpendicular to the axis; and calculation shows, in the like manner, that the second decrement, which takes place by two ranges, produces planes parallel to the axis, and thus the secondary solid is a regular hexahedral prism.

To display farther the structure of this prism, let us remark, that in the production of any one, $abcni$, fig. 1, of the two bases, we may confine ourselves to consider the effect of one only of the three decrements which take place around the solid angle a , fig. 4, for example, of that which takes place on the angle baf , supposing that the laminæ applied on the two other faces, $fagx$, $bagc$, do not decrease but to assist the result of the principal decrement, which takes place in regard to the angle baf . But here these auxiliary decrements are altogether similar to that the effect of which they are supposed to prolong. The case will be totally different if we apply the same observation to the decrements which are effected by two ranges on the inferior angles baf , dfx , fxg , &c. and which produce the six planes of the prism. For example, if we consider the effect of the decrement on the angle dfx , it is necessary also that the laminæ applied on the faces $afdb$, $afxg$, fig. 4, should experience towards their lateral angles afd , afx , adjacent to the angle dfx , variations which second the effect of the generating decrement. But here these variations

tions are intermediary decrements by ranges of double molecu λ e.

To conceive a better idea of these variations, let us resume the face *abdf*, fig. 49. The variations in question will take place parallel to the lines *ce*, *rx*, *gz*, *vy*, &c. that is to say, by one range of double molecu λ e, and in such a manner that there will always be two laminæ on a level at their edges in the direction of the height. By this it is evident why the laminæ taken from the prism by the first sections are trapeziums, such as *plus*, fig. 1, in which the assortment of the small composing rhombuses will be the same as on the trapezium *usop*, fig. 49. We may in the like manner assign the reason of the different figures through which the laminæ, successively detached, before arriving at the nucleus, are obliged to pass. But this detail would lead us too far. Every thing is included in the effect of the principal decrements: that is to say, in the present case, of those which take place on the superior and inferior angles, or parallel to the horizontal diagonals; and after the first lamina of superposition, the figure of the crystal is given according to this single condition, that the initial faces be prolonged so as to intersect each other.

The prism is susceptible of varying in the length of its axis compared with its thickness, which depends on the different epochs at which the decrements commence, or are supposed to commence. For example: if we suppose that the decrement, which takes place towards the inferior angle, acts alone at first on a certain number of laminæ, the axis of the crystal will be so much the longer as the commencement of the decrement on the superior angles shall have been retarded. This difference of epochs becomes sensible by inspecting the dodecahedron, fig. 2, which is one of the results of the mechanical division of the prism. It is there seen that the pentagonal laminæ of the summits, such as *A O I R S*, decrease only by their edge

edge *RS*, which corresponds to the inferior angle *bdf*, fig. 4, while, by their upper parts, they continue to envelope the crystal without experiencing any decrement towards that side; so that it is only on the laminæ most distant from the axis, as that corresponding to *psul*, that the two decrements take place at the same time. The result which we have explained is general; that is to say, that, whatever may be the angles of the primitive rhomboid, the secondary solid will always be a regular hexahedral prism.

2. AMPHITRIGONOUS IRON ORE.—Fig. 50 represents this crystal in a horizontal projection, and fig. 51 in perspective. *Geometrical Character.* Respective inclination of the triangles *gcn*, *gcd*, &c. from the same summit $146^{\circ} 26' 33''$; of the lateral triangles *bgu*, *bgq*, to the adjacent pentagons, such as *gutmn*, $154^{\circ} 45' 39''$.

This form is that under which the iron ore of the island of Elba most commonly appears. It results from a decrement by two ranges on the angles, to the summits of a cubic nucleus which produces the isosceles triangles *gcn*, *gcd*, *ncd*, fig. 50 and 51, and of a second decrement by three ranges on the lateral angles *cbp*, *crp*, *crs*, &c. which produce the triangles *mnr*, *rnk*, *ugb*, *qgb*, &c. These two decrements stop at a certain term, so that there remain faces parallel to those of the nucleus, viz. the pentagons *gutmn*, *hdnkl*, &c. fig. 50.

The first decrement is the same as that which produces the rhomboidal iron ore. The second has this property, that, if its effects were complete, it would give a dodecahedron of isosceles triangles, or composed of two right pyramids united at their bases. In the case of any other decrement by two, four, or more, ranges, the faces of the dodecahedron would be scalene triangles. The triangles of the summits are frequently furrowed by striæ, parallel to the bases

gn, dn, gd , of these triangles, and which point out the direction of the decrement.

3. ANALOGICAL CALCAREOUS SPAR, fig. 52.—*Geometrical Character.* Inclination of any one, $imeh$, of the trapezoids of the summits to the corresponding vertical trapezoid $ecpg$, $116^{\circ} 33' 54''$; angles of the same trapezoid, $i = 114^{\circ} 18' 56''$; $e = 75^{\circ} 31' 20''$; m or $h = 85^{\circ} 4' 52''$. Angles of the trapezoid $ehog$, $e = 90^{\circ}$; $o = 127^{\circ} 25' 53''$; $g = 67^{\circ} 47' 54''$; $h = 74^{\circ} 46' 23''$; of the trapezoid $cegp$, $e = 60^{\circ}$; $p = 98^{\circ} 12' 46''$; c or $g = 100^{\circ} 53' 37''$.

Geometrical Properties. 1. In each vertical trapezoid the triangle ceg is equilateral. 2. The height ex of this triangle, is double the height px of the opposite triangle cpg . 3. In the trapezoid $ehog$, and the others similarly situated, the angle heg is a right angle. 4. If the diagonal gh be drawn, the triangle heg will be similar to any one aof , fig. 4, of those which would be produced by drawing, in the primitive rhombus, the diagonals bf, ad . 5. If in the trapezoid $emih$, or any other situated at the summits, the diagonals ei, mh , be drawn, the height el of the inferior triangle meh will be double the height il of the superior triangle mih . 6. The triangle mih is similar to half of the rhombus of very obtuse spar, divided by the horizontal diagonal; and the triangle meh is similar to half of the rhombus of the acute spar, divided in the same manner.

The numerous analogies by which this variety is connected with different crystalline forms, whether we consider certain angles formed by planes, as the angle heg of 90° , the angle ceg of 60° , or certain triangles obtained by drawing the diagonals of the trapezoids, have induced the name of *analogical spar*. It is derived from three other varieties, viz. very obtuse spar by the trapezoids $emih, fiht$, &c. metastatic spar by the trapezoids $emdc, ehog, ohtz$, &c. and the prismatic

prismatic spar by the trapezoids *bdck*, *cegp*, &c. which are consequently parallel to the axis.

It often happens that the trapezoids *imeh*, *fiht*, &c. are separated, by an intermediary ridge, from the vertical trapezoids *cegp*, *gozr*, &c. In that case the trapezoids *cdme*, *geho*, &c. are changed into pentagons. It is here supposed that the crystal is brought back to the most symmetrical figure, that is to say, having its surface composed only of quadrilaterals, as sometimes happens. This variety is found in Derbyshire.

4. ICOSAHERAL SULPHURET OF IRON, fig. 53. *Geometrical Character.* Respective inclinations of the isosceles triangles *PLR*, *PSR*, $126^{\circ} 52' 11''$; of any one *PNL* of the equilateral triangles, to each adjacent isosceles triangle *PLR* or *LNK*, $140^{\circ} 46' 17''$. Angles of the isosceles triangle *PLR*, $L = 48^{\circ} 11' 20''$, P or $R = 65^{\circ} 54' 20''$.

This variety results from a combination of the law which produces the octahedron originating from a cube, with that which takes place for the dodecahedron with pentagonal planes. The first law gives birth to the eight equilateral triangles which correspond with the solid angles of the nucleus, and the second to twelve isosceles triangles, situated, two and two, above the six faces of the same nucleus. The icosahedron of the sulphuret of iron has been confounded with the regular icosahedron of geometry, which differs from it very sensibly, since all its triangles are equilateral. It is demonstrated by theory, that the existence of the latter icosahedron is as impossible in mineralogy as that of the dodecahedron; so that among the five regular polyhedra of geometry, viz. the cube, the tetrahedron, the octahedron, the dodecahedron, and the icosahedron, the three former only can exist there, in consequence of the laws of crystallization. It is not uncommon, therefore, to find them among crystals of various kinds of minerals.

als. The icosaëdron of the sulphuret of iron is much less common than the dodecaëdron. It is found in solitary crystals.

5. POLYNOMOUS PETUNZÉ, or FELD-SPATH, fig. 54.—*Geometrical Character.* Respective inclination of the narrow planes $onkm$, $cfhg$, to the adjacent planes on each side, 150° ; of the planes $ctfg$, $PomN$, to those contiguous to them by the edges tF , PN , 120° ; of the heptagon $pGcldez$ to the enneagon $BzebnoPrs$, $99^\circ 41' 8''$; of the trapezium $dafc$ both to the plane $nbafhilk$ and to the heptagon $pGtcdex$, 135° ; of the facet $deab$ or $ABzp$ to the same heptagon, $124^\circ 15' 15''$.

This form, such as it is given by the mechanical division of secondary crystals, is that of an oblique prism of four planes, fig. 56, two of which, such as $GOAD$, $RBHN$, are perpendicular to the bases $ADNH$, $OGRB$. The other two, viz. $BOAH$, $RGDN$, make, with the former, angles of 120° at the ridges OA , RN , and angles of 60° towards the opposite ridges BH , GD . These planes are inclined to the bases at the place of the ridges GO , BR , $111^\circ 29' 43''$, and at the opposite ridges $68^\circ 30' 17''$. This form is at the same time that of the molecule. Theory shows that the two parallelograms $GOAD$, $OGRB$, as well as their parallels, are equal in extent; and that the parallelogram $BOAH$, or its opposite, $RGDN$, is double each of the preceding; which may serve to explain the roughness of the sections made in the direction $BOAH$, when compared with those obtained in the directions of the small parallelograms, and which are always extremely smooth and brilliant. Moreover, if the diagonal OR be drawn, it will be found perpendicular to OA and RN ; or, what amounts to the same, will be situated horizontally, by supposing that the ridges OA , BH , &c. have a vertical position.

The polynomous petunzé presents the most complicated variety hitherto observed among crystals of
this

this kind. To form an idea of its structure, let us suppose that *pbyr*, fig. 55, represents a section of the nucleus *AR*, fig. 56, made by a plane perpendicular to the parallelograms *GOAD*, *BOAH*, and subdivided into a multitude of small parallelograms, which are the analogous sections of so many *moleculæ*. Here the side *yr*, fig. 55, which is the same section of the cutting plane as *GOAD*, is greater than it ought to be in regard to the side *cr*, fig. 55, which is the same section as *BOAH*, fig. 56; but these dimensions are suited to those of the secondary crystal, and here occasion no difficulty, because we may suppose that the primitive form has been extended more in one direction than in another; for this form is only a convenient *datum* for the explanation of the structure, and the crystal consists merely in an assemblage of similar *moleculæ*; so that it is the dimensions of these *moleculæ* which remain invariable.

This being premised, we shall find, by comparing the figures 54 and 55; 1st, that the plane *fabnklh*, fig. 54, and its opposite, which correspond to *mn*, *dg*, fig. 55, are parallel to two of the planes of the nucleus, viz. *GOAD*, *BRNH*, fig. 56, and consequently do not result from any law of decrement; 2d, that the plane *PomN*, and its opposite, fig. 54, which correspond to *ao*, *eg*, fig. 55, are also parallel to two of the planes of the nucleus viz. *BOAH*, *RGDN*, fig. 56; 3d, that the plane *onkm* and its opposite, fig. 54, which correspond to *on*, *eg*, fig. 55, result from a decrement by two ranges parallel to the ridges *AO*, *NR*, fig. 56; 4th, that the plane *cfigh* and its opposite, fig. 54, which correspond to *my*, *dc*, fig. 55, result from a decrement by four ranges parallel to the ridges *GDBH*, fig. 56; 5th, that the plane *ctFg* and its opposite, fig. 54, which correspond to *fy*, *ca*, fig. 55, result from a decrement by two ranges parallel to the same ridges *GD*, *BH*, fig. 56, which decrement takes place on the other side of

these ridges. It may be seen by what has been already said, that decrements different in their measure give rise to planes similarly situated, such as *onkm* and *cfgh*, fig. 54, which is a consequence of the particular figure of the *moleculæ*.

With regard to the faces of the summit, the heptagon *pGtcdez*, fig. 54, is situated parallel to the base *BRGO*, fig. 56. The enneagon *BsrPonbez*, fig. 54, is produced in consequence of a decrement by one range on the angle *OB R*, fig. 56, or parallel to the diagonal *OR*; which decrement does not attain to its full extent, and leaves subsisting the neighbouring heptagon parallel to the base *BRGO*. It may be readily conceived, after what has been said on the position of the diagonal *OR*, why the line *ez*, fig. 54, which separates the two large faces of the summit, is situated horizontally, supposing that the planes have a vertical position.

The trapeziums *dafc*, *ApGC*, result from a decrement by one range on the ridges *GO*, *BR*, fig. 56. The facet *deba*, fig. 54, arises from a decrement by two ranges, parallel to the ridge *BO*, fig. 56. With regard to the other facet *ABzp*, which has the same position as the preceding, in respect to the opposite part of the crystal, it results from an intermediary law by a range of double *moleculæ* on the angle *OB R*, fig. 56. The rhombuses *bclh*, *klsu*, fig. 57, represent the horizontal sections of two of these double *moleculæ*, taken in the same range, and whose relation to the rest of the assortment will become sensible by comparing the rhombuses in question with those marked by the same letters in fig. 55.

The crystals of this variety are subject to a change of dimensions, which is, that the faces *pGtcdez*, *fabnklih*, and their opposites, which are at right angles on each other, are stretched out, in the direction of their breadth, in such a manner that they exhibit the appearance of a quadrilateral rectangular prism,

prism, the summits of which would be formed by the faces situated towards the ridges P N, F t. This variety is found in opaque crystals, and of a whitish, yellowish, and sometimes reddish, colour, in the granites of Auvergne, and of different countries. There are some of them in groups and some single, but the latter are uncommon.

Dr. Townson, in his *Philosophy of Mineralogy*, observes, that two laws appear to govern the mineral world: attraction of aggregation, and attraction of combination. To the first, mineral bodies owe their existence in separate homogeneous masses, in opposition to the state of accidental and heterogeneous mixture. They likewise owe to it their regular crystalline forms; and without this law, the solid parts of our globe would only have been a confused chaotic mass. To the latter we are indebted for the great variety of compound bodies which are the result of so few elementary substances, and likewise for the changes that take place amongst them; even the processes performed in the laboratory of the chemist are founded on this.

Bodies that are solid have their active powers centred in themselves, and eternal repose is the result; unless another body, in consequence of the attraction of combination, unites with them, when a new body is formed. But all bodies in a fluid state are combined with their solvent, and then their particles, thus separated, have little tendency to unite with each other. But, as soon as this solvent is withdrawn, the particles that composed the simple solid body again unite; and they unite according to particular laws; so that, under proper circumstances, they form regular polyhedral figures invariably the same. If several are mixed in the same solvent, they in becoming solid do not unite indifferently, and without selection, and thus form a heterogeneous mixture; though this would certainly be the case, did the great law of attraction,

traction, by which great masses are governed, prevail, where attraction is in the reverse ratio of the squares of their distances; but each unites exclusively with its own kind: and the consequence of this is, that, instead of a tumultuous chaotic mixture, beautiful crystals are formed, each kind having its own proper character. To the law of aggregate attraction then, we are indebted for every thing that is homogeneous and symmetric in the fossil kingdom. Though a very small part of our earth appears to be composed of regular crystalline bodies, yet all substances that have a sparry or spathous texture, are nothing but a more or less tumultuous assemblage of indeterminate and half-formed crystals. As far as our sight, even aided by the microscope, will extend, we see that the first rudiment of a crystal is its perfect form; that in this its embryo state, if we may use the expression, it differs only in size from what it will be hereafter. It is easy to conceive, that many minerals which have not regular forms, may nevertheless be the result of crystallization; and that we may go by degrees from the most perfect geometric figure, to the most tumultuous assemblage of crystalline particles. In the sense in which the word crystallization is here used, every concretion from a fluid state is the result of crystallization, and may exist either in the state of regular crystals, or be so irregular as not to be definable, or in the state of confused aggregated particles. These three different states, it is not necessary to observe, run into one another. It is in this latter state that many of the minerals that form entire mountains are found; probably all, except those which are formed of the powder, dust, or fragments, of other rocks, as the breccias, sand-stones, &c. yet even these are but the ruins of those which had been formed in this manner. It is, then, to this law we owe every thing that is crystalline, symmetric, and homogeneous.

However

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However important the law we have just treated of may be in the formation of fossils, it must be clear, upon an attentive consideration of its characters, that it can only be the cause of the aggregation and concretion of the elementary substances; that though it brought these out of their chaotic confusion into beautiful homogeneous masses, and regular symmetry, yet it never could combine them, and in various proportions, and thus create, from so few elementary principles, such a multiplicity of forms as are the result of these combinations. This is dependent on a quite different law, *the law of attraction of combination.*

As the science of chemistry is little more than the knowledge of the preferring or selecting disposition of the different elementary substances and their compounds, and its operations little more than the adjusting and disposing them to reciprocal action, every page of chemistry must bear witness to the existence of this law. It has this conformity with the last kind of attraction, and this difference from the attraction of great masses, that it only acts when the bodies are almost or altogether in contact.

Though this law merely concerns matter of different kinds, there is no universal rule that there should be a combination between any two of them indifferently; for, on the contrary, there are some that never will combine together. A great difficulty here arises relative to *mixture* and *combination*, which, though perfectly different in their natures, are sometimes not to be distinguished. There can be no doubt, but that the principal components of hard pellucid crystalline bodies are in a state of *combination*; but likewise there can be no doubt, that often adventitious matter is enveloped in their masses, with which they are only mixed. For we know by experience, that in many cases circumstances are such, that the crystalline matter is not able to reject the heterogeneous,

heterogeneous, but envelops it in its substance. This is often observed in rock-crystal, in which chlorite earth, actinolite, asbestos, &c. are found; and sometimes the former are so intimately mixed with it, and in such quantities, that the fossilist is inclined to refer it to a different genus. In the crystallized sand-stone of Fontainebleau, though the calcareous spar is mixed with twice its own quantity of sand, yet it assumes its usual crystalline form.

If it be then difficult in regular crystalline bodies to know which of their components is combined, and which only mixed; how much greater must the difficulty be to ascertain this in the great rocks, the result of confused crystallization! In these it is clear, if we reflect on what must have passed in their concretion, that nothing heterogeneous could have been rejected and thrown aside as in the formation of regular crystals, but that every thing mixed in the fluid mass must have been enveloped, and must now constitute a part. A means of ascertaining this may occur to some philosophers; and probably it may be this: that those components which are only mixed and not combined, may be readily extracted by certain reactives, which will not affect them if they are in a state of combination. But this, though true in theory, would be difficultly put in practice.

Some readers may probably ask, how these elementary substances can have been combined, and how they have crystallized, since neither the components nor the compounds are soluble in water. This question, we believe, has never been answered; and it has given rise to, or supported, the opinion, that fire has been the agent in these processes. Yet difficulties, at least equally great, will be found in this hypothesis, which it would be improper, on account of the great extent of the necessary discussion, to state. There can be no doubt that there was a time, when the present great masses and beds of rock were not

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in existence, when the elementary substances of which they are composed were free and uncombined; that these elementary substances were more simple than what we consider such at this day; which most chemists, though they have no hypothesis to support, are inclined to think are formed of still more simple elements. If this be granted, it may then be easily conceived that they were in a state of solution in water, notwithstanding our present elementary substances, the result of their combination, are insoluble in this fluid; just in the same manner as the very soluble bodies, the tartarous acid and the vegetable alkali, form by their union an almost insoluble compound. It should always be recollected, that there is now no process going on in nature similar to that by which our rocks and strata were formed.

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